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FATIGUE STUDY



FIG. 1

An example of a most efficient chair for a kind of operations that usually require walking from side to side.

This chair shows that with sufficient study the worker can be enabled alternately to sit and stand at the work, *Courtesy of Cluett Peabody Co.*

FATIGUE STUDY

THE ELIMINATION OF HUMANITY'S GREATEST UNNECESSARY WASTE

A FIRST STEP IN MOTION STUDY

BY

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AND

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TO

MR. JAMES F. BUTTERWORTH

Who in his zeal to help in the movement for the elimination of national wastes, disregarded the laws of fatigue and as a result entered the ranks of the cripples in whose behalf he had been working.



PREFACE TO FIRST EDITION

In the final analysis, that organization is best that has the best quality of workers. No organization can continue to be of first quality whose workers are over-fatigued. Other things being equal, that country will be most happy and most successful whose workers have the least unnecessary fatigue.

Aside from the pleasure one may obtain from it, it is the duty of every one to eliminate the causes of unnecessary fatigue, and to promote the dissemination of knowledge of how to recover most quickly from unnecessary and necessary fatigue.

Fatigue study rests on scientific investigation that requires the special training of an expert, and laboratory methods and equipment; but there are elementary methods of studying and eliminating fatigue that are not only so simple that any one can understand and apply them, but that are also a definite stage in the preparation of the fatigue study expert.

It is the aim of this book to outline both these preliminary methods and the scientific methods of fatigue elimination and to put the available material for fatigue study into such shape that any one interested may make immediate, definite, and profitable use of it.

PREFACE TO SECOND EDITION

Fatigue Study is of especial importance during this reconstruction period for the following reasons:

First, as a matter of maintenance. During the War enormous progress in eliminating fatigue and in providing for overcoming fatigue were made as a matter of necessity. Through these means output was increased and humanity conserved. There is grave danger now that the War is over, not only that the progress may not continue but also that the industrial world may fall back into less efficient pre-War methods.

Second, as a means of conserving waste and thus assisting to pay the enormous War debt. No waste is so startling, so enormous, so criminal as the waste of human efforts. Moreover, savings along this line lead inevitably to savings in the materials element and thus to conservation in all lines of activity.

Third, as a force for bringing about and

developing co-operation. Fatigue Study is of equal interest and importance to employers and employés. It serves not only as an admirable starting point for co-operation but also points out during its development other lines upon which co-operation can advantageously take place.

Abroad as well as in this country during the past few years, since the first edition of Fatigue Study appeared, there has been much valuable work done along investigating the nature of fatigue and discovering and installing devices by which the effect of fatigue may be overcome. There has not as yet come a widespread realization of the paramount importance of eliminating unnecessary fatigue through a scientific study of work and worker alike. This can only result when fatigue becomes a matter of interest to every member of the community and when fatigue elimination becomes a part of our everyday life.

FOREWORD

How big is the loss to our nation due to preventable fatigue?

Of the 110,000,000 people in the United States, it is estimated that more than 30,000,000 are engaged in occupations in which unnecessary fatigue reduces their output.

It is a conservative estimate that unnecessary fatigue costs each of these workers in their producing and earning capacity much more than 10 cents per day for each day.

Now to be conservative, let us say only 20,000,000 workers, 300 days, at five cents each per day.

This mounts to $300,000,000 per year.

Capitalize this on a 4 per cent basis and try to realize the possibilities of the Fatigue Study Movement in the United States.

Even this does not take into consideration the following:

1. The fatigue of the balance of the people in the households, etc.

2. The decline in health due to continued over-fatigue.
3. The loss due to idle days and increased labor turn over.
4. The losses in benefits resulting in hearty co-operation of employers and employés, possible only when both are solicitous of each other's interests and comfort.

Fatigue Study and Fatigue Surveys have invariably resulted in other additional economies and eliminations of unnecessary wastes.

Fatigue Study has principally to do with that part of the science of work that is most necessary for producing large outputs.

The greatest help in solving the present high cost of living is to enable the worker to do his work, with the least fatigue and hence in less time.

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FATIGUE STUDY

FATIGUE STUDY

CHAPTER I

A DESCRIPTION AND GENERAL OUTLINE OF FATIGUE STUDY: WHAT MUST BE DONE

Fatigue Study and Waste.

In "Motion Study" we stated: "There is no waste of any kind in the world that equals the waste from needless, ill-directed, and ineffective motions."[1] It is an aspect of wasted motions that we are discussing here. Wasted motions mean wasted effort and wasted time. One of the results of this waste is unnecessary fatigue, caused by unnecessary effort expended during time that must, as a result, be wasted. Time, a lifetime, is our principal inheritance. To waste any of it is to lose part of our principal asset. To waste time and to suffer from unnecessary fatigue simultaneously can be excused

[1] See "Motion Study," p. 2.

only by ignorance. Unnecessary fatigue is caused by some one's ignorance. This book aims to call the attention of the world to the relationship between fatigue and waste, with the hope that the knowledge of our methods of fatigue elimination may be useful to others.

What Fatigue Is.

A crowd of workers come out of the factory after the day's work. Some rush home; others walk at a leisurely pace. Some move slowly and with effort. Some have their heads back and a satisfied expression on their faces. Others have their heads bent forward, and look as though life were not worth while. What is the difference between the members of this group? Mainly a matter of fatigue. Fatigue is the after-effect of work. It is the condition of the worker's organism after he has expended energy in doing something. It is a necessary by-product of activity. If, as is presumable, every member of our crowd of workers has been putting in a day full of activity, we might expect to see the same marks of fatigue on every face and figure,—but we do not.

What, then, are the reasons for the difference? The state of fatigue has only been systematically studied during the past thirty years. Even today it is not wholly understood. We do know, however, several things about it, that may explain what we see in the emerging group. We know that fatigue is marked by a decrease in power to work, a decrease in pleasure taken in work, and a decrease in the enjoyment of the hours spent away from work. We know that exertion not only uses up temporarily the energy of the body, but that it also seems to generate a sort of poison which "slows one down" for the time being. In the third place, we know, also, that the effects of fatigue are more difficult to overcome as the fatigue becomes greater. Careful observation and records show that a little fatigue is easily overcome if proper rest is supplied immediately. Twice the amount of fatigue requires more than twice the amount of rest. Four times the amount of fatigue demands much more than twice as much rest as the preceding "more than twice the amount of rest," until, finally, a state of excessive fatigue requires a rest period that might have to be prolonged in-

definitely. It is this fact that lies at the basis of the great unnecessary waste in accumulated fatigue.

The trouble with these tired workers, then, is that their work has not been arranged in the least fatiguing manner nor in such a way that they could get the most rest and recovery in the least amount of idle time during the working hours. The ones whose heads are high and whose shoulders are thrown back may have been provided in some way with sufficient rest. The ones whose heads are bowed probably have not had the recovery time that they needed. It is possible that those who have had all the rest they needed have not produced as much as have the others. The remedy for this may not lie in shortening the rest, but in improving work methods. The waste in work not done, or in work done with the wrong method, is a serious economic waste. The waste in unnecessary fatigue is not only an economic waste, it is a waste of life, and it calls for immediate attention from every one of us, whether interested in the individual, the group, or the economic prosperity of our country.

What Fatigue Study Is.

Our fatigue study is an attack upon this unnecessary waste of human energy. It is a careful consideration of the problem of activity from the side of its results upon the human organism. It aims:

1. To determine accurately what fatigue results from doing various types of work.
2. To eliminate all unnecessary fatigue.
3. To reduce the necessary fatigue to the lowest amount possible.
4. To provide all possible means for overcoming fatigue.
5. To put the facts obtained from the study into such form that every worker can use them for himself to get more out of life.

The Field of This Book.

The reader who will carefully watch the tired crowd of workers will probably decide that he would like to do something about the fatigue problem immediately. There are various methods by which he may attack the problem. He may, and must, ultimately, review the literature

on fatigue. The work of Marey, of Amar, of Imbert, of Offner, of Thorndike, and of numerous other physiologists and psychologists lies open to the student of the subject. He may turn immediately to Miss Josephine Goldmark's masterly volume on "Fatigue and Efficiency." This will give him an insight into the application of fatigue elimination to the industries. He may decide, however, that such study must wait, and that he must actually *do something* to cut down the fatigue the first thing the next morning, while the driving force of what he has seen is still strong. Nothing can mean so much to what he is to do as the strong incentive that drives him to doing it, the desire to help. But he will do best if he is instructed and directed. He should plan, in order that he may do the most in the least amount of time, and do the big, easy, obvious things first.

This book will outline a method of attack, and furnish a working practice for attacking the fatigue problem in an industrial plant. This practice is recommended because it rests on the results of measurement. We have here not simply a collection of illustrations that show what has

been done in eliminating fatigue in the industries. All fatigue elimination is to be commended, but illustrations that do not embody well-recognized principles are questionable models. It is easy to make external changes that never touch the underlying cause of evil. Worthwhile, permanent fatigue elimination goes at the fundamentals of the work itself, and studies these in relation to the fatigue. *What* has been done is worth while when we know *how* it has been done, and *why* it has been done. Given these facts, we can determine how it may be done again in the same fashion and possibly even better. The practice that is the result of *accurate measurement,*— this is the standard to be demanded.

The Relation of Fatigue Study to Measured Functional Management.

Fatigue study is founded on measurement. This makes it an integral part of measured functional management. This is management that acts in accordance with standards. These standards are derived by actually measuring accurately what is happening. Standards contain the results of the measurement combined into new

working methods. These standards are maintained only until they can be improved, when the new ones are in turn measured and maintained. Such accurate measurement demands that the problem of management be divided into measurable units. These units are made as small as possible, and constantly smaller as time goes on. It was the great work of Doctor Taylor to divide an operation, that is, a piece of work to be measured, into units for timing with a stop watch, and to *separate rest units from work units.*

From its beginning, Scientific Management has recognized the importance of the part played by fatigue. This recognition helps to obtain that co-operation and permanent beneficial efficiency that are the underlying ideas and the maintaining forces in this type of management. But fatigue study has only recently been acknowledged as fundamental to the most efficient management. Any one can attack the fatigue problem in its present condition in the industries successfully. He has simply to apply measurement. He can do this without regarding the investigations and results of others, if he chooses, but he will pro-

gress faster and farther if he uses results already at hand, and improves on "the best that has been known and thought in the world."

Relation of Fatigue Study to Motion Study.

Motion study has been described as the dividing of the elements of the work into the most elementary subdivisions possible, studying and measuring the variables of these fundamental units separately and in relation to one another and from these studied, chosen units, after they have been derived, building up methods of least waste. It is through the measuring of motions that one comes to realize most strongly the necessity of fatigue study.

There has come, in the past twenty-five years a strong general realization that the important factor in doing work is the human factor, or the human element. Improvement in working apparatus of any type is important in its effect upon the human being who is to use the apparatus. The moment one begins to make man, the worker, the centre of activity, he appreciates that he has two elements to measure. One is the activity itself. This includes the motions, seen or

unseen, made by the worker,— *what* is done and *how* it is done. The other is the fatigue. This includes the length and nature of the interval or rest period required for the worker to recover his original condition of working power.

Any one who makes real motion study, or analyzes motion study data, cannot fail to realize constantly the relationship of motion study to fatigue study. The fatigue is the more interesting element, in that it is the more difficult to determine exactly. When we recognize this close relationship between motion study and fatigue study, we see that we have a body of data already collected and at our disposal. What is even more desirable, we have a method of measurement ready at our hand. Every observation of a motion may be used to give information about fatigue. Is this information of immediate use to the man who is attacking his fatigue problem for the first time to-day? Yes, and no. Yes, in that it is at his disposal. No, in that he must determine his own particular problem before he can start to solve it. The first step in this direction lies in classifying fatigue.

The Classes of Fatigue.

There are two classes of fatigue:

1. Unnecessary fatigue, which results from unnecessary effort, or work which does not need to be done at all. A typical example of such work is that of the bricklayer, who furnished one of the first subjects for motion study. Any one who has watched a bricklayer lift all of his body above the waist, together with the bricks and mortar from the level of his feet to the top of a wall, cannot fail to realize that bricklaying requires a great amount of energy as well as skill. Yet by far the most of the energy expended in the method of laying bricks, that had existed for centuries, was entirely unnecessary.[1]
2. Necessary fatigue, which results from work that must be done. The new method, which enabled this same bricklayer to lay three hundred and fifty bricks per hour, where he had laid one hundred and twenty bricks per hour before, did

[1] See "Bricklaying System," chapter xiv. Myron C. Clark Co., Chicago.

not eliminate, and did not expect to eliminate all of the fatigue accumulated in the working day. The bricklayer at the end of the day, by reason of motion study devices, laid more brick, but was nevertheless much less tired. Experimental work in his case was carried to a high degree of perfection, because he was recognized as a splendid type of efficient brawn.

The Problems of Fatigue Study.

The problems of fatigue study are, then, four, which may be stated in very simple terms:

1. To determine what fatigue is unnecessary.
2. To determine what fatigue is necessary.
3. To eliminate all unnecessary fatigue possible.
4. To distribute the necessary fatigue properly, and to provide the best possible means for speedy and complete recovery.

The Methods of Fatigue Study.

The methods used must rest on a scientific basis. These methods are the same for the expert and for the man making his first attack on the problem. They are as follows:

1. Record present practice, make an accurate and complete account in writing of what is actually being done.
2. Decide in what sequence things are to be measured, and put them in such shape that they can be measured.
3. Apply accurate measurement.
4. Determine standards synthetically from the measurement, and make such changes in practice as will make it conform to the standard.
5. Compare the new standard practice with the old practice. Determine exactly what improvements have been made, in order to be able to predict the line along which new improvements must lie.

This is the standard method of attack of measured functional management. It can be the more successfully applied to fatigue study in that the results can be checked at every point by the results of motion study, which bear a constant relation to them.

Emphasis in Fatigue Study.

Any such study as this demands an emphasis upon accuracy. The man making the study must

have a strong desire for finding and writing down the facts. He must have willingness to submit every aspect of the problem he is studying to the test of accurate measurement. Along with this desire for facts must go a realization of how the facts are to be used. Fatigue study is a constructive study. It builds up. It uses such terms as "elimination," but its fundamental aim is conservation, and this conservation includes adding to those things which make life worth while. The desire to act as a force for betterment must be the incentive that makes the man doing fatigue study ready to record and face the actual facts.

A Work for Every One.

Recording facts is difficult work, but there is no one who cannot do some of it. It is the duty of every man to face the facts with which he works and to record them. You have come from the crowd of tired workers with an incentive to do this. Here is the method by which it may be done.

Summary.

Fatigue study is related to motion study in that both are branches of waste elimination. Fatigue study classifies fatigue, and outlines methods by which unnecessary fatigue may be eliminated and rest from necessary fatigue may be provided.

CHAPTER II

THE FATIGUE SURVEY: WHAT IS TO BE DONE

What a Survey Is.

A survey is an attempt to record existing conditions. It gives:

1. A general view.
2. A more particular or intensive study of the various parts of the whole and their relation to one another.

It may include recommendations for improvement, but its primary purpose is to record what actually exists.

The survey is a *systematic* study of existing conditions. Those making it have always a well-defined plan in mind. It is necessary, in order to maintain a proper balance for the completed survey, to give a properly proportioned representation of what happens, with no element omitted or over-emphasized.

The General Survey and the Fatigue Survey.

The fatigue survey should be a department of the general survey. A description of the apparent causes of fatigue, or of the devices present that eliminate fatigue, can mean little without the accompanying description of the worker, the conditions of the work and the work itself. The fatigue survey might be made without a general survey. From the results, fatigue might be eliminated, or better means for overcoming fatigue provided, but there would be no assurance that the records applied would be efficient, or do lasting good, if the causes of fatigue were not understood. The causes could not be understood without the general survey. The fatigue element receives more emphasis than any other element of the general survey. We look for fatigue first, last, and all the time, but we record with it all the attending circumstances that we can observe or discover.

The Aims of the Fatigue Survey.

The fatigue survey aims:

1. To present an accurate picture of existing conditions from the fatigue standpoint.

2. To enable all interested in fatigue elimination to visualize the problem thoroughly.
3. To divide the problem of fatigue elimination into such working units that it may be possible to attack the problem successfully from the start.
4. To arouse the interest of every member of the organization in fatigue and its elimination.
5. To show the relation between fatigue and activity.
6. To teach every member of the organization to conserve his working powers.

The Time and Place of Making the Survey.

The survey should be made as soon as plans for making it are completed, and before any changes in the actual practice are made. If there is any idea of changing the type of management, it may well be made even before such a change is thoroughly outlined. It is the first step to be taken by any organization which is thinking of introducing the scientific type of management. The entire "plant" should be surveyed. The work

should start where there is the most fatigue, and where the greatest amount of good can be done immediately. This, for several reasons; such as:

1. The largest amount of waste can thus be eliminated.
2. The co-operation of the workers will be most quickly gained. This will be true not only of the workers actually studied, but of all of the workers in the organization. They will appreciate the attitude of the new management, and will be glad to help if they can see the actual benefit from the start.
3. The survey maker will become encouraged as he sees his data successfully used.
4. The survey, if made by an amateur, will help him when he attacks more difficult problems.

If the survey maker is an amateur, he had best begin where working conditions most demand betterment. It is simpler to record working conditions than to describe the worker or the method by which the work is done. A really adequate record of a worker requires a knowledge of physiology and psychology. An adequate record

of method requires an expert knowledge of motion study. A preliminary record of fatigue of all sorts may be made by an amateur. He had best, however, get his practice in recording working conditions. Moreover, it will be best to observe a worker who is known to be co-operative at the start. The co-operation of the worker is the most important element in getting accurate records. Such workers will also help from the start to suggest or invent devices for eliminating fatigue, if they are started thinking along these lines. Later, one can handle the non-co-operative as one becomes more practised, and there is always the likelihood that, by the time one gets to these at first non-co-operative workers, their attitude will have been changed by the good results and the general sympathy towards the fatigue survey.

The Qualification of the Survey Maker.

The survey maker must be an accurate observer. He must be able to see what the conditions really are, and to describe and record what he sees in simple, clear language that will enable others to understand what he says. The survey

may be made by any one of several types of survey maker:

1. The owner of the plant. He will have the most vital interest in the resulting fatigue elimination. No matter who else makes a survey, the owner should examine it closely, or should make one for himself. We have found that, if the owner can be persuaded to take one day of his time to make even a most rapid and superficial fatigue survey of his plant, the result is always of enormous benefit to the work; but, while his interest may be enlisted with a walk through his plant, his zeal will not be obtained until he has actually sat in the various seats and chairs, and actually, personally, tried out the various work places.
2. The survey may be made by some other member of the organization, who is an amateur at the work. The benefits of having a survey maker who is a member of the organization is that he "understands the peculiar and local conditions" thoroughly, and that those who are ob-

served may therefore have more confidence in his work and perhaps may be less apt to resent being observed. The disadvantages are that he will be so well acquainted with and accustomed to seeing the conditions that he will not be apt to note many apparently unimportant details. These may really be important, when one comes to make changes.

3. The survey may be made by an amateur not a member of the organization. The advantage of this is that the observer will be disinterested. The disadvantages are the usual disadvantages of lack of training. There may, also, be some delay in the observed worker's co-operating with the observer. This is not apt to occur if the survey maker is properly instructed before he begins his work.
4. The survey may be made by an expert. It makes little difference, in this case, whether the expert is, or is not, a member of the organization. In actual practice he seldom is a member of the organization.

There is much saving in time in having an expert survey maker, who will be, in the industries, preferably a motion study expert. From extensive practice he will be able to see possible improvements at the same time that he sees existing conditions. However, he must not let his plans for improvement affect the exactness of his records of the present. On the contrary, these plans will insure that he makes his records of the present detailed and accurate, in order that the progress may be apparent.

Whatever may be the preparation of the survey maker, his chief qualification should be a keen interest and enthusiasm for this work. If a man really wants to eliminate fatigue, and is willing to learn how to do it, he can become a survey maker.

What to Look For.

There are three chief groups of things to look for:

1. The characteristics of the worker, or, as we have called them, "variables of the worker."
2. The characteristics of the working con-

ditions,—"the variables of the surroundings, equipments, and tools."

3. The characteristics of the methods of work; that is, "the variables of the motions." [1]

First, in describing the worker, there are several possible methods of obtaining valuable information. One is by observing him. A second is by talking with him. Before using either of these, it is necessary to see what records of him are already in the hands of the management. There will probably be some information in the employment bureau, if an employment bureau exists; if not, the man who hired him may have some data concerning him. Usually this will save the worker's time in answering questions. It is well to know as much as possible about the worker's life history and home conditions,— this especially that one may understand whether he goes to work refreshed or tired in the morning.

The procedure may be as follows:

1. Record the man's name, age, birthplace, preparation, experience, and fitness.

[1] See "Motion Study," pages 6 and 7.

These last will all be a help in determining the percentage of fatigue.

2. Record the man's physical characteristics, as far as can be observed; such as, size, strength, skill, strong points, and weak points.
3. Record, as closely as possible, the man's behaviour, as indicating his mental condition. To be specific, note whether he seems interested in the work. Note his habits of doing the work,— whether he does the work the same way every time, or whether he varies in his methods. Note his degree of ability to learn quickly, Note his power of concentrating attention. Note his degree of contentment with the work.

The degree of detail with which this notation may be made by an amateur doing the work depends largely upon his training in psychology.

Second, in recording working conditions:

1. Record those things that affect all workers in the group. These are the length of working day, condition of lighting, heat-

ing, cooling, and ventilating; fire protection; safety protection as it affects all,— this to include protection from dust, lint, or any substance which might affect health.

2. Record the conditions that affect the individual worker: — places of the work; the work bench or table or other device for holding the work; the chair, foot rails or rests, or other device for affording rest to the body or some part of the body; the material worked on and its placing; the tools or other devices by which the work is done; the clothing of the worker.
3. Record the results of the work: — the average amount of output; the hours of the working day when most fatigue seems to exist. Record which conditions observed are the result of work having been done by the management, and which are the result of work having been done by the individual worker.

If a general appearance of fatigue seems to occur at any time, make special notes of all attending conditions of every kind. Note anything

that is particularly good or particularly bad.

Third, little can be done at this stage by the amateur survey maker in recording the variables of the methods, and in making motion analysis charts. He may, however, make notes of methods that seem to him unusual or efficient. For example, if he observes two workers who seem physically much the same, and who have practically indentical surroundings, and finds that one of these accomplishes more than the other, or is less fatigued, the difference is likely to lie in the motions or the methods used. These should be carefully noted. Such data as these will prove of value in the intensive studies of motions to be undertaken later.

Variables that Affect Fatigue.

We included in "Motion Study," [1] a list of forty-two variables that affect motions. The list we use consists of one hundred and nineteen. We feel that our list is by no means complete. It is necessary only to note here that every possible change in the work, the worker, or the method has its effect upon the fatigue. This

[1] D. Van Nostrand Co., 25 Park Place, New York City.

need not act as a deterrent from making changes. It need only act as a warning that no change made without a thorough consideration of every element of the problem can be of permanent value.

The Survey Record Sheet.

The survey maker will do well to list all of the things, which he intends to look for, upon one sheet, which he may use as a tentative record sheet. Such a sheet will prove itself an admirable record of how far advanced the organization is in fatigue elimination. The survey maker in any particular plant may modify it to suit individual conditions.

The making of such a record sheet is most stimulating to the survey maker. He should make a collection of all the different survey sheets obtainable, even though used in the social or educational fields. He should be required to make at least a tentative sheet of his own. Through his attempts to do this, he will come, as in almost no other way, to a realization of the importance of the problem that is before him.

Survey Photographs.

A photograph is one of the most satisfactory survey records. It is not always easy to get such a photograph. In the first place the survey maker is not sure what should be photographed. In the second place the worker is not always eager that he or his work place should be photographed. This is even more true of the management than of the men. Some managers are not willing to allow their work places to be photographed, when they realize that such photographs will live as "before and after" records. Where photographs can be taken, they are the ideal records, in that they are accurate, detailed, unprejudiced, easily understood, easily preserved, and constantly available. We have found the photograph the most valuable of records, and have used it continuously since 1892. On every side we find that scientists are more and more realizing the importance of the photograph record. A trained photographer often has the desirable qualities to become an admirable survey maker. The motion picture film makes it possible to record activity as well as rest.

Making the Survey Serviceable.

Such photographs form an important element in making the survey serviceable. The survey is an admirable record to use after improvements have been made, to show exactly what the trend of progress has been. It is, however, most important, as furnishing the working data from which the actual improvements are made immediately. To be serviceable, then, the survey must do certain things:

1. It must make it possible for any one studying it actually to realize existing conditions. It is apparent what a help the photographs are in thus visualizing the problem.
2. It must emphasize those conditions that require immediate and great improvement. These can be shown most plainly by photographs, but it must be remembered that a photograph without a proper written explanation often means but a small portion of what it should to a man who has not himself seen the conditions.
3. It must be in such form that it can be

easily followed or studied. This will be assured if the plan has been properly made, and if the plan outlined has been consistently followed.

The observations should be grouped. The groups should be put under appropriate headings. The order should be excellent. It will help greatly if partial and final summaries are included.

The amateur will do best to put all of his recommendations for changes at the close of the survey. Such recommendations should certainly be included. The survey maker should note the improvements that occur to him while making the survey. This he may do on the regular survey blank, but when writing up the survey, he should put his suggested improvements in a separate place, for the following reasons: His suggestions may be good, but may be only a few of possible suggestions. Reading them *with* the survey may prevent the reader from thinking out suggestions of his own. Again, the suggestions, while good, may be obvious, in which case the reader might consider the entire survey a record of obvious facts, which, therefore, is of little

value; in which case, while it is well to record them, it is seldom advisable to include them in the body of the survey. The reader may lose interest because of the suggestions, and may fail to realize the value of the record itself.

Another means of making the survey serviceable is to pay strict attention to the style. This should be the extreme of simplicity and clearness. Use short, familiar, and necessary words. Use short sentences requiring no punctuation except the period. In fact, wherever possible, use a printed form, and write in the fewest possible words that can include a simple, definite, and complete description. Wherever possible, make the survey so interesting that it will hold the attention without effort. This has been done, and can always be done. Photographs, especially stereoscopic photographs, are of great assistance; so are charts, or graphs, illustrating the results of the observation; and tables that will show facts, recapitulations, and tendencies, at a glance.

The data of the survey may be written up by the survey maker, if he is clever at such work; if he is not, it had better be written up by some one

to whom he explains it, and who is naturally a clever writer.

The survey in proper form can be used as a force to arouse interest in fatigue elimination throughout the entire organization. It must be put in the most attractive form possible. As an illustration of the possibilities in making dry material interesting, study the farmers' bulletins used by the national government and various State governments, especially the bulletins of Kansas and Wisconsin.

It is a courageous organization that would consent to making its original fatigue survey public However, the survey should certainly be in the hands of every member of the organization who desires to see it. It will be recognized that the survey is the starting point for making improvements in the elimination of unnecessary fatigue. Too little is often done to take the workers into the confidence of the management. The fatigue survey might well act as a starting point in this direction; therefore, if not the entire survey, it is certain the examples worthy to be copied should be freely circulated. The efficiently, specially-clothed worker, the excellent arrangement

of tools, the best arranged work place,— photographs and descriptions of these might be posted to excellent advantage.

After all, the real aim of the survey is to be serviceable. It will be most serviceable when it is used by the greatest number of individuals, and it will be chiefly serviceable in that it stimulates them to do something definite to improve conditions. It must suggest *what* is to be done, and *where* it is to be done. As to *when* the improvements are to be made, there are certain things that can be done immediately,— as soon as existing conditions are understood. Our next task is to show what these are, in order that the stimulated organization may expend its energy for the greatest amount of permanent good to the greatest number.

Summary.

The fatigue survey is a record of present conditions and practice, that endeavours to show particularly and in detail where and when fatigue exists. This record contains a description of all the attending circumstances. It is to be in such form that it may be easily read and un-

derstood. By studying it, any one interested may learn where fatigue exists, and may receive suggestions as to how it may be prevented, eliminated, or remedied.

CHAPTER III

PRELIMINARY PROVISIONS FOR REST FOR OVERCOMING FATIGUE

Provision for Rest.

The first necessity in our fight against fatigue is to eliminate the causes of unnecessary fatigue. The second is to provide for proper rest to overcome fatigue, whether necessary or unnecessary.

If the worker goes home too tired each night, the first method of remedying this condition is to provide rest periods during the working day — to set aside time in which he may recover his proper and normal working strength. One method by which this may be sometimes done is by shortening the working day. This permits the worker to get into better condition either before work, after work, during a lengthened noon hour, or during the "second breakfast" and "tea recess" of many European organizations. The supposed advantage of this plan is that it gives

little or no jolt to the working process. To this we might answer, as circumstances vary, that it does give a jolt, because speed must be increased in order that output should be maintained; or we might say that the jolt is really needed. The disadvantage, in some cases, of shortening the working hours is the effect upon the entire industry in the vicinity. This is a feature to be considered, for in the long run maximum prosperity is dependent upon largest outputs. There can be no doubt that in most cases it is advisable and profitable to shorten working hours, but how and when this is to be done is a serious problem. In our own office, our stenographers work every other Saturday till 1:00 P.M. only, and the alternating Saturday they do not work at all; that is to say, we give them a holiday of Saturday afternoon and Sunday every other week, and all Saturday and Sunday the other weeks, besides their regular two-weeks vacation in summer. We find that we get more and better work as a result. No plant, operating under the measured type of management, that we know of, has ever regretted shortening its working hours. It may be that the working hours

formerly existing were so long that shortening the hours was the only immediate adequate remedy. The danger in shortening hours is that, if the whole problem is not thoroughly studied, the worker may not be sure of the same or a larger wage for work which he is able to do in the shorter time. Fatigue elimination is fundamentally the duty of the management. The worker cannot afford to pay for the fatigue elimination, directly or indirectly. Let the short hours be planned for and assured, but make sure before introducing them that everything is in such condition that wages can be maintained or raised. This is a matter requiring study of actual records and not "guess," "personal opinion," or "judgment."

There are other methods of providing for fatigue elimination or recovery, that do not involve so many elements. Such a method is providing rest periods during the working day. This is a method that may be used immediately. To whom are these rest periods to be given, then? Ultimately, of course, to every member of the organization whose work is of a nature that requires a fixed rest period. The work should,

preferably, be so arranged that every worker, be he in plant or in management, would achieve larger outputs by having definite and properly located rest periods. It has been proved in most work that more output can be achieved by applying one's self steadily for short periods, and then resting, than by applying one's self less steadily and having no rest periods. This, of course, applies only to work which in itself provides no rest periods. At the beginning of the fatigue eliminating campaign, provide rest periods for those who seem to need them most. There are two, off-hand, quick methods of determining which workers these are. One is the appearance of the workers at various times of the day, and at the end of the day. The other is the amount of output and the rate that output is turned out by the worker during the day and during the various parts of the day. In some organizations, it has been the standard practice to take no chances when the worker looks or feels tired. They provide rest periods immediately, long enough to allow him to recover and go back to the work with zest. This is, of course, the immediate remedy. "Provide the rest period first.

Discuss its efficiency later." This first-aid plan has worked splendidly for a long time among women workers in such industries as the dry-goods trades. The typical welfare work may be unscientific from the standpoint of those familiar with highly organized methods, but it has sensed the trouble keenly and quickly, and provided at least a temporary remedy without delay. "Time to rest when one needs it." This is the first slogan of the campaign for eliminating the evils of overfatigue.

Chairs to Make the Rest Most Effective.

The merchants have again been the pioneers here, in realizing that reclining chairs or couches furnish the most effective rest. It is not necessary here to discuss the physiological effects resulting from a change of blood pressure. It should be noted that even a few minutes in a reclining position provides such rest as could not be gained in a much longer time if seated upright in the most comfortable of chairs. If attending conditions allow of reclining chairs or couches, for at least the exceptional and emergency cases, these should immediately be provided. It surely

does take real courage for the management of an organization of strong and strenuous men to install reclining chairs, couches, and high foot-rests for rest periods; but fame awaits the one in this field, who can make the practice general. The brain worker of all types has long realized the benefits of the occasional use of the reclining chair. Flat couches without even the smallest of pillows are a part of the regular working equipment of some of our greatest brain workers. It is considered no disgrace, nor is it worthy of note, if a tired soldier flings himself flat upon the ground to rest. It attracts no attention for an exhausted worker to go to sleep on a hard wooden bench at noontime. But to put a couch in some quiet spot, or even a chair with extra-high, large, flat, arm rests, where the same type of rest might be enjoyed most effectively, *this* seems radical, and "might make the men think we had gone crazy." It might be objected that the worker should not allow himself to become so fatigued that this type of rest is necessary. The answer is,—if rest in this position will overcome what is almost complete exhaustion, what increases in national efficiency and prosperity

may it not cause in overcoming quickly less violent stages of fatigue?

Next to the couch or reclining chair, in efficiency, is the arm-chair. There are "arm-chairs," and chairs with real arms specially fitted to the individual worker. These will be even more efficient if provided with a foot-rest. We have actually installed such arm-chairs out in the works with very good results. We have had many a case where even the workers laughed loudly when the special, unusual chairs were brought in. They began to use them more out of friendliness towards us than out of any belief in the special usefulness of these peculiar chairs. However, at the end of a few days of actual use, they were able to handle their work in greater quantities and with less fatigue. "It's a joke to work like that," one said. Some of the workers claimed that they did not need such a chair, but, after it became the fashion to use it, each one seemed glad enough for the better rest provided.

From this type of chair down to the smallest possible seat, the gradation is gradual and constant. In certain types of work, like selling in

a drygoods store, the space is sometimes so narrow that the only type of chair practicable, under present conditions, is the small folding seat that can slip under the shelves or fold up against them when the girl is serving a customer. Such also is the type of chair that folds up under or next to a machine, which the operator is tending, and which can be pulled out during the periods when the machines need no tending, and the operator is simply inspecting or waiting for the next tending period. Every one realizes the advantage, as a resting device, of anything upon which one can occasionally sit. The two-inch, iron arm of a seat on a railroad train, the tiny seat that folds into a walking stick or umbrella, that the enthusiast at the races takes with him,— these are typical examples of seats that seem almost ridiculous, yet that have an enormous effect upon the amount of fatigue accumulated in a few hours, or in a day. "A chair to rest in;" this is the second slogan. If a chair is not procurable, then some sort of a seat, even a packing box with no back, even a post to lean against, or a rail to lean upon,— anything to shift the pressure is better than nothing. Far better a seat with no

back, immediately, than the best type of chair in the indefinite future. Get some sort of seat for the worker to-day, and begin planning for the efficient chair at the first day possible.

The final word on chairs in this preliminary work is that some sort of a chair should be provided for every member of the organization. There is a wide-spread belief that one chair for every two or three or more workers is sufficient; that "they can change off using it." The argument was something like this: "No one needs to sit more than one-third of the time, therefore one chair to each three workers is enough," etc. The chief fallacy is the implied idea that the rest periods of the workers can be so arranged that the chairs can be in constant use, and that each worker will have a chair at his or her disposal at the proper time. Now in theory, of course, this is not an impossible arrangement. It might have to be made if chairs and seats cost many dollars apiece, and it probably would be done then, if there was a proper realization of the importance of overcoming fatigue. But when chairs are as cheap and plentiful as they are now, there is no excuse for thinking of such

a condition. In practice, where there are not enough chairs for every one, at certain times of the day the chairs are empty, as every one is busy. At other times, when work is duller, the chairs are all used, and many workers are trying to rest as best they can, standing. These conditions can be noted in any drygoods store, in any shop or factory where there is an inadequate supply of chairs. "A seat for each and every worker whether he needs it or not;" this is the third slogan.

Betterment Work.

The third division of provision for rest falls under the general heading of betterment work, or what is popularly called "welfare work." The term "betterment work" is used by those who are interested in measured management instead of "welfare work," to emphasize a distinction in thought. Some welfare work implies that it is the gift of the manager to the workers. Betterment work is the same type of work, done with the distinct understanding that what is done is for the good and profit of the organization. It is the due of every member of the or-

ganization to have the best resting condition possible. Making these conditions better is betterment work. There is no intention to criticize welfare work. Most welfare work is betterment work. Some workers, however, object to welfare work as implying "charity." Therefore, we say betterment work. It is the worker's due that he gets. Such work comprises establishing rest rooms, lunch rooms, entertainments — anything that can make the resting time more attractive and profitable. It may also imply the service of a betterment worker or a staff of such workers; or it may be that the organization itself takes up the work co-operatively, with no outsider to direct it. Doubtless some such activity already exists. If so, it would be the duty of the fatigue eliminators to recognize it and encourage it.

The fourth provision for rest is really a part of betterment work. It must be described at some length. This is the Home Reading Box Movement, which furnishes a definite means for making rest periods, both at work and at home, attractive and profitable. Before turning to a description of this, we may estimate the effect

upon the worker of the preliminary work so far done.

Results.

The results of the preliminary work we have done are as follows:

1. The interest in fatigue becomes more vital. We have aroused more interest in fatigue elimination, and have made it general. With the establishment of properly distributed rest periods, chairs, seats, etc., the recovery process becomes interesting. As he knows how resting improves his working conditions, the worker becomes more warmly interested in the fatigue itself. It is a very different thing to talk about the evils of fatigue, or even to see the advantages of proper rest exhibited in object lessons, than it is to get proper rest in a specially designed chair for the first time in one's working life. Fatigue, which was *an* enemy, becomes now not only *my* enemy, but *our* enemy — mine, because I recognize it has affected me; *ours*, because we

are fighting it together for our best interests, severally and collectively.

2. The interest in fatigue becomes more intelligent. Many workers, especially women, feel that it is to be expected that they will get exceedingly tired by night; that one cannot expect to do so much late in the day as early in the day; that stopping to rest is cutting down one's output, thus cheating one's self, if one is a piece rate worker, or cheating the management, if one is a day rate worker. The worker now comes to realize that he hurts the management *and* himself, when he gets too tired. "It is your duty to rest when you need it;" that is the fourth slogan. It must be remembered also that the rest periods provide time for clearer and more intelligent thinking. It is impossible to come to any valid conclusion when one is working at top speed part of the day, and in a state of exhaustion the rest of the time. We have now an opportunity to think, and brains rested enough with which to think.

3. The output increases. Usually, in practice, the output increases as a result of the fatigue-recovery periods. Increased outputs encourage both management and worker. They must, however, be inspected and controlled. Some one with the proper training must be in charge, that excessive fatigue may not be accumulated, and the rest periods lose their purpose. With the increase in output must come added compensation in wages. If this is provided, the fatigue eliminating campaign will not be regarded as a new scheme for driving the worker. Better for the good of the management and the men to limit the output to its usual amount during this period, until the workers see that too much fatigue today interferes with the standard quantity of output to-morrow, than to attempt to allow increased output without increased pay. The world can better afford to lose the extra product, than the management to appear even for a moment to be trying to overwork the men.

4. The spirit of co-operation grows. The worker realizes instinctively, if the survey has been properly made, and if this preliminary work has been properly done, that the aim of fatigue study is the good of all concerned. There is a psychological element to this. It might be possible to question the motive of installing fatigue eliminating devices. There is no question as to the motive in installing the resting devices and rest periods. The rest periods allow time for development of the social spirit. "To know all is to understand all," a wise Frenchman has said. "I like every one whom I know," is the thought of another wise man. "Let's go at the fatigue survey all together," is the fifth slogan. The Home Reading Box Movement is, perhaps, the channel where this spirit of co-operation expresses itself most freely.

Summary.

Preliminary provision for rest for overcoming fatigue consists of establishing rest periods, pro-

viding chairs or other devices in which one may rest, and establishing or encouraging betterment work. These result in a more vital and intelligent interest in fatigue, and a spirit of co-operation. This work is embodied in five slogans. These are as follows: "Time to rest when one needs it;" "A seat to rest in;" "A seat for each and every worker whether he needs it or not;" "It is your duty to rest when you need it," and "Let's go at the fatigue survey all together."

CHAPTER IV

THE HOME READING BOX MOVEMENT

What It Is.

The Home Reading Box Movement is a system of placing interesting, educational, and valuable reading matter at the disposal of the workers in an industrial organization. It consists of

1. A box in the plant in which the reading matter can be placed and kept until taken out by the workers.
2. Boxes in the homes of members of the organization or of the community interested, where reading matter intended for the plant can be kept until it is collected.
3. A system by which the reading matter gathered in the homes is taken to the plant reading box, is taken from the plant box to the homes of the workers, and, in turn, either returned to the plant or passed on to other homes which would have pleasure or profit from it.

The Box in the Plant.

The box in the plant is located at a place most convenient for the workers. Its size depends upon the size of the collections. It should be large enough to hold two collections of papers, magazines, and books. It should be located where the workers can get to it without loss of time and with fewest motions. The best place is usually near the path of exit after the day's work. It will simplify the routing of the reading matter, if the box is put under a window next to the street, so that magazines can be put in by any one driving or walking by, without coming in and thereby possibly disturbing the operation of the plant. The box is made a regular part of the plant equipment by receiving a station number like every other "station" on the messenger's route. The first box installed happened to be No. 34. All boxes since have received this number, and the same number becomes the home reading box symbol, thus,—"34."

The Plant as a Source of Supply.

It is invariably a surprise to the management, as well as the workers, to find how much reading

matter for the home reading box is available in the plant itself.

Every business man receives quantities of catalogs and other business and technical literature, and sample copies of publications, sent in the effort to get new subscribers. These are glanced at by the man receiving them, and then and there usually thrown into the waste-basket. A catalog is the best literary effort of the concern it represents, and usually contains valuable instruction. Now if the mail sorter or the purchasing department see no immediate need of the things in the catalog, it usually finds its way quickly to the waste-basket. That such catalogs have a decided interest to the users of the home reading box is shown by the fact that new catalogs are always taken away to the homes. The average manager has not the time to give each catalog the attention that it really deserves, but in the majority of cases there will be one or more men out in the plant who have both the time and interest to devote to the catalog. These usually discarded catalogs are sometimes read to see if they will not contain a thought for the "suggestion" box; the by-prod-

uct being that the plant is kept up to date, so far as information contained in new catalogs is concerned. In the same way sample magazines or papers may come in, which make no particular appeal to the man to whom they are sent, or a magazine brings a marked article which is cut out and put on file,— the rest of the magazine being thrown into the waste-basket.

All of this usually discarded material can be, with profit, sent to the home reading box. The man in the office, who looks at and discards it, simply stamps or writes on it "34," the symbol of the home reading box, or the number of its station in the inter-office postal system, and puts it in his "out" basket. On his next trip for distributing papers, the messenger takes the reading matter marked "34" from the "out" baskets, and deposits it in "34," the home reading box.

Another source of supply consists of the newspapers, magazines, or books bought by the members of the organiaztion as they come to work. The average man in the management departments buys a paper or magazine as he comes to work. His daily paper is surely discarded, his

magazine is often discarded, sometimes even a book is thrown aside as completed. These also go through the "out" basket to the home reading box. A cent or two a day for a morning paper is little or nothing to some members of the organization. A cent or two a day is a very important element in some working men's budgets. Besides there is an enormous waste, if daily papers are thrown away after having been read by but one person.

The Home Element.

A home reading box which has no other source of supply than that mentioned is not to be despised, but many advantages of the movement are lost, of course, if it is so restricted. It is desirable and customary, therefore, to interest as large a number of homes as possible in the movement. There are, first, the homes from which reading matter comes. The first problem is to arouse interest in such homes. The conversation goes something like this:

"Haven't you some reading matter that you wish to get rid of, that we could have for the Home Reading Box Movement?"

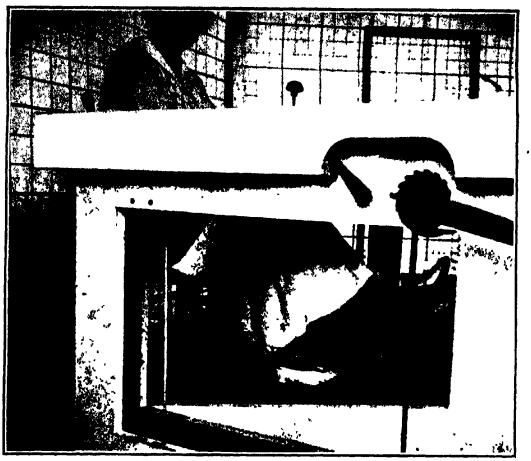


FIG. 2



FIG. 3

FIGURES 2 AND 3

Motion Study Laboratory.
Experiments for determining the most efficient foot rests.
Courtesy Remington Typewriter Co.

"Just what do you want?"

"Well, anything that is interesting, but especially magazines of recent date, with which you have finished."

"Oh, but we get hardly any magazines. Let me see. We do take the *Saturday Evening Post,* and my wife reads the *Home Journal* and the *Woman's Home Companion,* and I buy some of the weeklies and some of the monthlies."

"And you get trade catalogs and trade papers of various kinds besides?"

"Oh, yes, we get some of those that pertain to our business."

"Well, what do you do with them all, when you have finished reading them?"

"Why, we throw the advertising matter into the waste-basket, and the trade papers we keep with the idea of binding some day, but we never have bound them. I don't know exactly what does become of them. I don't think we ever really look at the old ones."

It is this reading matter that we desire to send promptly into some home reading box. As to the other homes to which the reading matter ultimately goes, these may be, or may become,

or may help others to become, the same type of home. At present little reading matter, can enter, because the wage earner cannot spare enough from his wages to buy much literature, and is too tired to go to the library in the evening. There is often the same desire for reading in this home, though it has not had such a chance to become trained. The whole family has the same desire to see the pictures, and the children the same joy in colouring the drawings or cutting them out. The neighbours will like to borrow anything that is interesting, and the reader will increase his stock of information and his vocabulary, and form the habit of reading besides. There are exactly the same possibilities of developing habits and tastes. All that is lacking is the opportunity.

The one hope for the working man is through education, and the greatest educational possibilities now, with very few exceptions, go into the waste-baskets of the nation. For example, consider the pile of *Saturday Evening Posts* that come out each week. These would make a pile more than three miles high each week. Think

of the many other magazines and their effect upon homes that cannot afford to buy them.[1]

Routing the Magazines.

The whole problem is to get the magazines from the home to the plant promptly and in the easiest way possible. When the first home reading box was established, we carried the magazines in our arms from our homes to the plant, where the magazines found their way to the home reading box by means of the inter-office messenger system. As other people became interested, there were more magazines than could be conveniently carried, so we sent an automobile around, now and then, for collecting the magazines and taking them to the plant. Gradually other people were asked to co-operate, and regular collections were made monthly by some member of the organization, who had time and an automobile at his disposal. If the auto was busy or the weather bad, an express wagon or a truck went the rounds. The aim, however, was, and is, always to have the collecting a part of

[1] The publishers are all in favor of the Home Reading Box Movement, as it creates readers.

the co-operation plan. It became a common sight in the town where the movement started to have a college professor take a Saturday afternoon off, and collect the magazines in his electric coupé, or to have one of the boys and his chums go out in a touring car, and fill the box at the plant, so that the men would find a fresh supply Monday morning. In some plants, where none of the homes in the vicinity has reading matter, it is boxed and sent by express from friends of the movement at a distance. Some bundles have come from as far as Bryn Mawr for the Home Reading Boxes in Providence.

It is a great sight to see the big bundles come in, and to watch the workers, as they are opened. Every one is allowed to take what he pleases and as many as he pleases. There have been no restrictions whatever, because the unhampered privileges have not been abused. He may bring any back, if he chooses, or he may keep all he takes, or he may pass them on to his less fortunate friends or neighbours who are not employed in a plant having a home reading box. He is rather urged to pass them on when he has finished with them, as we wish to maintain the

reading club, or circulating library, idea. We consider the reading matter as loaned, and to be passed on in an endless chain. If the worker chooses to consider what he gets as a gift, that is his privilege. He may break the chain without reproach; in fact, breaking the chain has been the cause of starting real libraries on a small scale in many houses.

The Problem of Maintenance.

There are various important features to the maintenance problem. In order that the supply may remain sufficient, as large a number as possible of co-operators must be secured, and they must, naturally, be required to do the least amount of work possible.

In Providence, where the work started, the work was, during this first or starting period, placed in charge of a young man who devoted considerable time to putting it on a systematic basis. He divided the city into four districts, each district representing a telephone exchange district. Routes for collection were made out, and volunteer collectors assigned to the different routes. Notices of collections were sent out,

and schedules strictly adhered to. Co-operators were, of course, allowed to keep their magazines in any place or in any way that they chose, but were urged, when convenient, to place the collecting home reading box in their respective front halls, near the front entrance, where, on the day that the collector called, the box could be emptied by him into the waiting automobile with least possible delay to him and with the least inconvenience to the household. As the list of subscribers, or co-operators, has grown, it has been a simple matter to amplify the routes. The same methods of collection are maintained.

In another plant, each member of the organization is responsible for what he can collect, and brings it to the plant himself.

At a girls' college, where there is a branch, the girls collect the magazines in the dormitory, or ask their parents and friends to express what they have finished with, and then box the supply at intervals and express it on to the selected plants. We recommend this method because it is so simple.

At the present time the home branch demands a very small amount of time for operation.

"Make it easy for every one," might well be the motto of the home reading box movement. The "out" basket and the inter-office system furnish the solution for the office force. As for the worker himself, the placing of the box where it will be most convenient for him has already been emphasized. Choose a place where the worker can pick the magazines up on his way out at noon or at night, with room enough around the box to allow half a dozen people to stop, select, and chat as they turn the magazines over. One must actually see the workers reading the magazines noon times, instead of, as formerly, losing consistently at poker to the foremen, in order to appreciate the full benefits of the home reading box movement. It may seem surprising to see the workman carrying home two to four dollars' worth (in original cost) of magazines each week — reading suited to every member of the family. But there is really nothing strange about it. This is what he would always have done had he had the chance.

A second factor in maintenance is keeping the reading matter up to date. When the movement is first started, the workers will take any-

thing home, out of interest or curiosity. In districts where there is little reading matter available outside, they may continue to take home almost anything put into the box. But with continued reading they become more discriminating. This is, of course, exactly what is desired. Then the reading matter, to make the strongest appeal, must be timely. A morning paper is exciting in the morning, quite readable at noon, not impossible at night. Except as practice in reading, it has little value the next morning. A May magazine issued in the middle of April is current literature through May 31st. It becomes a last month's magazine on June 1st. Any one enjoys carrying the magazine of the month about with him. It is a fact that most men, especially those who do not have many magazines, feel a little peculiar when seen reading an old magazine of current events in public. They have the consciousness of conspicuousness that at least distracts the attention. No magazine that has pictures or stories or articles on travel, or anything that is interesting at any time, will go without a great circle of readers, but current events must be current in order to hold the at-

tention thoroughly. The workers will be glad, in the average plant, to get *anything* to read, but, if you want to keep them excited, send the magazine out the moment that you have finished with it at home, so that it will be this month's magazine. The strong preference for this month's magazine may not be founded upon wisdom, but it is very human.

How the Conditions Vary.

The home reading box will prove a success in any plant, no matter how simple the installation and running plan are, but it can only retain its best results when a careful consideration is given to the conditions that affect the particular problem. The important feature is, of course, the type of worker who is to receive the literature. Where the group of workers consists of foreigners, many of whom read no English, and speak it little, the picture magazines are the most sought. Where you have a group of highly skilled mechanics, technical magazines and trade catalogs are highly appreciated. There is such a great difference in the workers of any one place, that the rule is to give them anything

and everything — from the *Outlook* to the *Police Gazette,* inclusive. If you give them enough to read, they will sooner or later waste none of their time on anything but the best. The desire for good reading is almost wholly a matter of education, and the best way to become educated is to *read, read, read.* If you are at a distance from civilization, old magazines will be almost as welcome as new.

You must realize that the problem is different in different cases. What some people need is general education. Of course, that is what we all need, but the worker in particular. What others need is specialized teaching. What still others need is relaxation. All need amusement and entertainment. We want, of course, to supply what is interesting and profitable, but the final test is giving the worker the thing that will please him most, that he will delight to have, that he may increase his vocabulary and learn to read quickly, for not till then will he acquire the reading appetite and habit. Give the foreigner who reads with difficulty the pictures with the simple captions that he can "spell out." Give the factory girl the woman's magazine that

will show her how to trim her hats and fix her dress, and that may give her all sorts of useful home ideas besides. Give the inventive mechanic the technical and trade magazine that may supply the missing link in his invention or suggestion. Give the socialistic worker the "Political Economy Journal," that will put his ideas in more logical shape. Use discrimination in your distribution when you can, but, if you cannot, put the box in anyway, fill it with reading matter, and *start something to-day.*

The Home Reading Box and Fatigue.

Not only is the influence of the home reading box upon fatigue important, but the amount of fatigue existing has a strong influence upon the home reading box. The home reading box plays an important part in recovery from fatigue. It is a help to the worker during the time that he is not at work. It is the psychologist's task to investigate the relation of mental fatigue to bodily fatigue, and the proper amount of mental stimulus to prescribe or allow during the periods when the body is resting; but it is good practice, while waiting the results of the psychologist's

investigation to be formulated into industrial terms, to encourage the worker to read whatever he likes.

The By-products of the Home Reading Box Movement.

There are so many important results from the home reading box movement that it is difficult to decide which are the products and which are the by-products. Let us call the product the fatigue elimination for which we planned, and that results when we establish the home reading box movement. Along with this come the following:

1. The recognition of fatigue elimination as a vital part of management. This is secured by numbering the box as a station, by using the "out" baskets as routing channels, by having the messenger carry the magazines to the box from the baskets as part of the daily routine.
2. The education of the worker. Quite aside from the fact that the reading matter interests, amuses, or rests him, the worker is educated by his reading. It

is this side of the movement that has most interested sociologists and educators. The chief trouble with the worker to-day is that he needs more and more education. The average worker has two obstacles. In the first place, he has a limited vocabulary that retards his speed in reading. In the second place, he cannot read educational matter fast enough to hold his attention. Through the reading matter put at his disposal, he does learn more words,— both how to recognize them and how to use them. He thus becomes better able to express himself, as well as a more rapid reader. Of course this implies mental development. The worker who is better educated to start with also acquires more vocabulary and more speed. It may be a technical instead of a general vocabulary, but the development is the same.

3. The stimulation of invention. This takes place through the ideas obtained from the technical magazines and trade catalogs. We have noted time and again

men who have said, in effect,—"You know I got this idea from an article I read from the box;" or, "You know I have had this idea for a long time, but I could not see exactly how to work it until I saw a picture in a magazine I got out of the Home Reading Box;" or, again, "I saw a picture the other day that suggested something that we could use on my machine. I am going to turn in the suggestion to the Suggestion Box." The suggestion box and its use are to be described at length later.

4. The stimulus towards making suggestions for prizes. It is noted here that the reading not only stimulates the worker making suggestions, but gives him a chance to put his ideas into more practical and working shape. Where the Suggestion Box has been running some time before the Home Reading Box has been put in, we note the sudden rise in the number of suggestions offered after the installation of the Home Reading Box.
5. Co-operation with public and travelling



FIG. 4

The Public Library Branch at the New England Butt Company, Providence, R. I., for eliminating the necessity, and consequently the fatigue, of journeying to a regular Public Library.

libraries and other educational institutions. A plant library is becoming a regular institution. It is usually one of the first things introduced by the welfare or betterment department. The problem is to make the workers take out the books. In some plants the management also buys books and starts a circulating library. In others, the public library sends a loan collection that is changed as often as the plant desires. Even in districts where there are no public libraries such books are available, as most of the States have State loan collections of this type. In a typical New England plant the librarian of the city was more than willing to cooperate. He asked the plant to supply a list of books which he should send. His letter was discussed in the foremen's meeting, and every member present helped by submitting a list of books that he had read and enjoyed most in his life. From these lists a list of fifty books was made up and sent to the librarian, who pronounced it the best list that he had

ever seen. The books were promptly brought to the plant, and put in a convenient place where every member of the organization could see the titles and borrow them. The first book taken out by an Italian labourer was Dante's "Divine Comedy" in the original. But the library at the plant is another story. The influence on the home reading box is to make the library much more popular and to affect markedly the books in greatest demand. There is a strong influence also seen upon the number of workers who attend evening school at the general evening school or some of the special evening schools in the vicinity.

6. The influence upon clubs and other organizations. The home reading box furnishes also topics for discussion in all of the organization of members of the plant. This influence can be noted in foremen's meetings, in organization meetings, and in any formal or informal gathering of the organization. The influence is seen in the topics discussed and

in the form and style of the discussion. The worker can speak with authority, if some magazine or catalog "backs up" his ideas. He can bring new light on the problem, if he has seen several views presented in the material he has read. He has a definite suggestion, something to say when he is called upon, something to volunteer if he is not called upon.

7. The spirit of co-operation. Most important of all the spirit of co-operation is fostered, co-operation among the workers, co-operation of worker and management, co-operation between all interested in the movement as subscribers, as collectors, as readers, as "passers-on." As a positive force this spirit of co-operation is more valuable than anything else.

How to Begin.

Begin by interesting the management force and insuring a supply of reading matter. Then put up the box in the plant, and tell the men that whatever goes in it is at their disposal. If you have the right ideas back of it, the develop-

ment is inevitable. Your motto must be "Keep the box full." The "how" will come to supply the need. The workers will see to keeping the box empty, if you do your part properly. The important thing is that the movement be started at once. It is not only an important part in making more pleasant the time spent in recovering from fatigue, but also an enormous help in fatigue elimination. It is to this that we must next turn our attention.

Summary.

The Home Reading Box Movement is a method of putting reading matter at the disposal of the worker. It collects this reading matter from the homes of those interested and from the desks of members of the organization who have finished with it, and places it in a box. The workers take it from this box to read either during noon rests or at home. The movement not only helps to overcome fatigue, but has many valuable by-products, and is an important element in fatigue elimination.

CHAPTER V

PRELIMINARY FATIGUE ELIMINATION: WHAT CAN BE DONE IMMEDIATELY, AT THE VERY BEGINNING

The Lighting Problem.

It is not necessary to have a scientific knowledge of motion study, physiology, and psychology, or even of hygiene, in order to make preliminary, anti-fatigue improvements in working conditions of any industrial organization that has not already had a regular fatigue survey made. We might profitably begin with lighting, since no fatigue is more wearing than eye fatigue. We attempt here only to ask a few general questions about the light. "Is there enough light, so that every one can see his own work perfectly?" "Is the light properly distributed?" "Is glare prevented?" Etc. Nearly all factory managers of to-day are careful to provide enough light for the worker. In their desire to furnish light enough, many workers often have more

light than is really comfortable, and are forced to adjust their eyes constantly in order to see distinctly. The lighting to be found in most factories is not properly distributed, and seldom strikes the work at the least fatiguing angle.

The greatest fatigue from lighting, however, lies in the question of glare and reflection. One sees examples of this everywhere. It is caused largely by a misplaced pride in equipment or machinery, and by keeping everything in a high state of polish. One is often disturbed and inconvenienced in even the best equipped public libraries by the glare of the electric lights upon the shiny, varnished, or otherwise highly polished surfaces of the desks. Oftentimes we see lights carefully placed so that the individual gets light enough with his light in the right location, while lights in the distance shine in his eyes. Even when the lights are provided with adjustable shades, it is almost impossible to place one's book in such a position that reflected light will not shine from the page to the eyes. The glare from nickel-plated machinery, be it a large factory machine or a typewriter, or any other kind of shop or office equipment, will cause fatigue, if

the eye is required to work constantly in the vicinity; but the source of fatigue is not recognized. A dull black finished machine may not be as beautiful either to manufacturer or purchaser as would be a shiny, nickel-plated machine of the same design, but the main question is, "How much comfort will the operator take while using the machine?" The kind of finish of such machinery is usually affected greatly, if not determined wholly, by the question of salesmanship. Good appearances have always been a large element in making sales, and it is natural and right that the manufacturer should like his product to be attractive in appearance, and that the manager should take pride in the looks of his factory or office. But our entire standard of what is desirable in "good looks" in a work place has changed. We look now for efficiency and fatigue elimination rather than for ornament and glaring polish. We reduced fatigue, annoyance, and distraction on several pieces of work by having our clients paint nickel and other bright parts with a coat of dull black paint. For the best results to the eye, the same finish as that on the inside of a camera is to be recommended.

We are coming to realize more and more that the great test of everything is suitability, and that the mysterious and tangible thing called "suitability" simply consists of the measure of predetermined units of desired qualities. The operating room in the hospital is bare, with plain walls and rounded corners, with the least opportunity for dust lodgment, because that is most suitable to the type of work done there. The modern business desk is flat topped, with no tiny drawers or cubby-holes to collect papers and miscellaneous odds and ends, because this type of desk conforms best with present day systems of office management. In the same way all machinery and office equipment should be without so-called ornament or polish, because in this way the most work can be done with the least amount of fatigue. Our whole idea of ornament is changing. Suitability here also is the standard, and the artists have done noble work in setting an example to the trades. "Suitability" must become a slogan for every department in the organization.

The new doctrine will interest the selling department, who act as intermediaries between the



FIG. 5

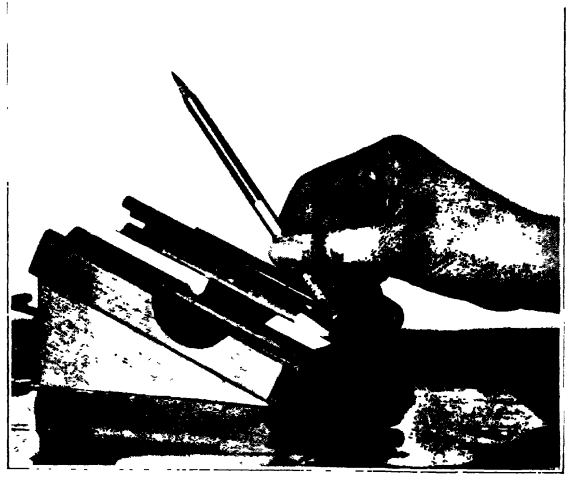


FIG. 6

FIG. 5

This photograph shows a typical "motion-studied" desk. This desk is cross-sectioned, so that standards can be made as to the placing of those things that are constantly required for work. The only drawer containing any permanent materials is pulled out at the left. It contains duplicate supplies of our standard forms, so arranged that a man will not run out of supplies at his desk, as the holder in which the reserve supply is placed is a notification to the desk supply boy that supplies in addition to the weekly furnishings are wanted immediately.

FIG. 6

This picture shows a "one-motion" pencil rack. This is one of the many little devices that we have used to cause every one throughout the plant to think in terms of elementary and least fatiguing motions. This pencil rack was devised little by little, suggestions coming from different employees. For example, one suggestion was that the grooves be painted different colours, representing the standardized places for the different coloured pencils. Another suggestion was that a deep horizontal groove be added, that the fingers might go around the pencil at the exact place where used when in the position of writing. The slant of the rack is that slant whereby the pencil will surely slide down by gravity to the stop at the bottom of the pencil rack, but not slide with force enough to break even the most delicate point.

Such a device alone saves very little time or fatigue, but it represents one of many kinds of devices that make for habits that cause less fatigue.

manufacturing department and the public who is to buy the product. It will be a real part of the preliminary work in adjusting such conditions as lighting to take the sales department and purchasing department into conference on the subject. Let all interested see that nothing comes into or goes out of the plant until the question, "What is its relation to fatigue?" has been considered. We forget sometimes that a thing may have value not only because it has certain qualities that eliminate fatigue, but also because it lacks certain qualities that would cause fatigue.

Go, then, through your own plant with the question of glare in your mind. Examine and inspect every work place, and see what can be done. Not only for reasons of glare, but for other reasons we recommend that every work place should be inspected for unnecessary fatigue by having a man, competent in fatigue study, actually sit and stand in the working position in each and every work place in the establishment once every three months during the installation period, and not seldomer than once per year thereafter. Sometimes it will be found that moving the nearest light or shading a distant light

will be all that is necessary. Sometimes a coating of dull black paint on some of the working equipment is required; sometimes the substitution of a dull-finished for a glossy paper. Sometimes dull-coloured blotting paper can be laid upon the place where the reflected glare comes. Perhaps a dull finish upon that would not only save the time of your workers, but also those who are to use the product after it leaves your hands. The world worked a great many years under the motto, "Give the public what it wants." We are beginning to realize to-day that the public will want just exactly what it is educated to want; also that the public is easily educated if the arguments that are used are based upon measurement, and are presented in attractive form. The lighting problem is but a small element of the problem of eye fatigue. This will, however, be left for later consideration.

The Heating, Cooling, and Ventilating Problem.

This problem has to do with different aspects of seeing that the worker is provided with proper air. We are beginning to realize that the air problem is much more complicated than was for-

merly thought. Recent investigations have gone to prove that the temperature of the air is fully as important as the supply of air, and that humidity is another important element. In this day no one can feel satisfied with his solution of the air problem who has not submitted it to an expert, and installed the results of his measured investigation. In the meantime, safety lies on the side of providing more fresh air than is necessary. If there is plenty of fresh air, unless the work itself demands peculiar temperature or humidity conditions, the worker is fairly safe. The rest periods that are being installed will do much to solve the air problem, as they furnish an admirable opportunity for giving the work places a thorough ventilation, if not a complete "airing out." This is not in the least to underestimate the importance of proper temperature and of proper humidity, as will be noted later. All measured records of outputs should include records of the temperature and the humidity. The accumulation of this data is daily bringing nearer the time when standards covering these will be available. In the meantime, give the worker plenty of fresh air *all the time.*

Fire Protection.

The average manager to-day realizes fully the necessity for fire protection. It is not, perhaps, so fully realized that the mere knowledge that there is adequate fire protection has a considerable effect upon the mental comfort of many of the workers. Nothing is more fatiguing than worry. When each worker in the establishment knows that in case of a fire he can leave the building with speed and perfect safety, he has absolutely no worry or distraction from the fire standpoint.

Fire protection should include not only seeing that the building and all it contains are made as fire-proof as possible, and installing all possible devices for putting out a fire should one start, but also the fire drill. Here the motto of the Boy Scouts is useful, "Be prepared." There is nothing so satisfactory as preparedness. The fire drill is not only a means of handling the organization during a fire, but it is also a splendid preparation for meeting an emergency. The great problem that arises in any unexpected situation is the problem of making a decision. If

one can acquire the habit of making a decision quickly, and can also make habitual certain decisions in certain situations, the resulting speed and fatigue elimination is remarkable. Make the response to the fire situation, then, standard. You will be benefiting your workers not only by teaching them how to act in any fire anywhere, but also by teaching them how to respond to a signal in a standard way. These various sets of habits in response to various stimuli should be formed in the first years of the school life, if not before. They are being formed at this time to-day to a greater extent than ever before, but unfortunately the majority of adult workers in the industries have never had such training as children. It, therefore, becomes the duty of the management to form such habits as rapidly as possible.

Safety Protection.

Safety protection in its broadest sense covers not only protection from grave dangers, but from anything that might have a harmful effect upon the worker's body or mind. The standard to be set is that everything should be safe not only

when the work is done by experienced adult workers, but even should it be done by inexperienced, immature or tired workers. We know how many accidents happen to the inexperienced worker, that would never happen to the experienced worker. We all know how many children are hurt, where an older person would see and avoid danger; and we note every day, more and more clearly, that the exhausted worker is to an enormous extent more susceptible to accidents than is the rested worker. It is usually the tired motorman who has the collision. The tired locomotive engineer passes the stop signal. The exhausted motorist is in the accident. The tired operator gets his fingers caught in the machine. The overtired sickroom attendant gives the wrong medicine.

One side of the fatigue elimination question is that fatigue elimination cuts down accidents. The other side is that cutting out the chance of accidents eliminates fatigue. Here again the question of worry is an important element. If one knows that the working conditions are absolutely safe, he can concentrate his attention upon the work in hand.

It is coming to be understood not only that it is mandatory that working conditions be made healthful, but also that it is perfectly possible, and, in most cases, easy to make such conditions healthful.

Look over your conditions, then. Put the proper safety devices on the machine, the tools, etc. Install the vacuum cleaners that will collect the dust and lint. Put the goggles or nostril-guard, or other device, on the worker, that will insure to him clean air and decent working conditions. Make a scientific attack upon the problem later, but put in a safety device now, even if you have to change some of it next week. You will gain the immediate return that will make the investigation pay from every standpoint in the changed attitude of your workers, if in nothing else. The Museum of Safety Devices, with its energetic and enthusiastic secretary, will show you what has been done and what can be done in the line of safety. "Safety First" has become the slogan of the day. If we make it "Safety First, beginning now," we shall have full working directions.

The Work Place.

The working conditions that we have so far discussed have more or less effect upon all of the workers in a group. We come next to the inspection of the work place of each individual worker. The first consideration here is that he have room enough in which to work. There is an enormous amount of fatigue involved in doing work in an overcrowded work place, yet few workers or managers realize this. Again, habit is involved here, and the habit of order demands that the work place be kept in an orderly condition. Any one who has walked through factories, shops, or any places where work is going on must have noted the tired appearance of the workers among what is called "clutter." The girl selling ribbon, who walks up and down behind the counter through an accumulation of paper, cardboard cores, and other odds and ends, has not only the bodily fatigue of pushing the clutter ahead, or kicking it aside, but also the mental fatigue that comes from adjusting herself constantly to such conditions. The folder of cloth, who has barely enough room to move her

hands because of the supply of finished and unfinished materials, is fatigued from the clumsy position, even though she and no one else realizes this. The office worker, whose finished and unfinished papers are heaped in confusion before him, expends not only useless motions in getting at and disposing of what he wishes to handle, but also mental energy, in constantly adjusting and readjusting himself to the work. There has been a popular idea that it "looked busy" to have plenty of work around, that to see work to be done would impress both managers and workers with the need for applying themselves to the work more constantly and with considerably more speed. This may be true if the work is arranged in an orderly fashion, but disorderly work is far more likely to discourage than to stimulate the worker. As for completed work, there is no excuse for leaving large quantities of it at the work place one moment longer than is absolutely necessary. Any encouragement that it might give the worker could better be given by a record of what he has done.

The Work-bench or Table.

Few work-benches or tables should be considered as absolutely satisfactory that do not permit the worker to do his work standing or sitting. Our ideas as to proper work-benches or tables, and as to the proper placing, height, etc., of machinery and tools have too often been prescribed to us by the manufacturers of the articles, who have thought more of what was convenient to manufacture than of what was least fatiguing to use. Such manufacturers are not to be blamed in the least for their attitude. They, naturally, have been guided by what would sell best. They have, as a rule, shown themselves more than willing to supply any legitimate demand. The user must demand what will be best for his work. It is no slight, short-time job to determine the proper height, positioning, and layout of a work-bench, using this term in a general sense to cover the place of any kind of work upon which the worker is engaged. As preliminary work, we may, usually, then, boost everything that can be so lifted to such a height that the worker, at his option, may stand or sit. If it becomes a case

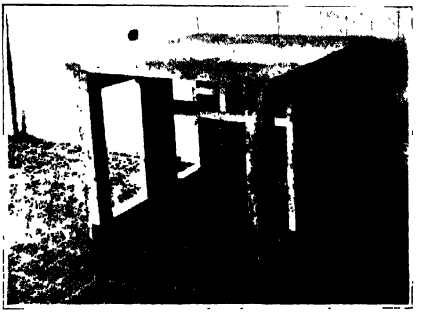


FIG. 7

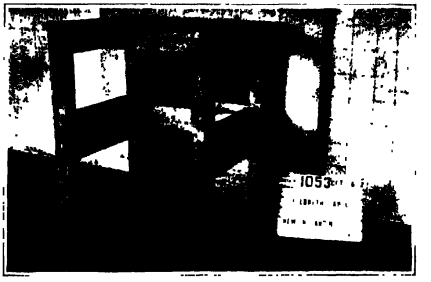


FIG. 8

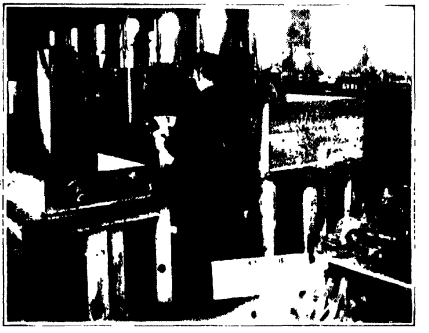


FIG. 9

FIG. 7

This picture shows the Gilbreth table laid down in its lower position. This table is particularly adapted for a work-bench or table where it is desired to have two different heights for different kinds of work. The table and its load can be picked up with a booster truck in either this position or the higher position simply by operating the lever of the booster truck and without touching the table at all.

FIG. 8

This picture shows the Gilbreth table standing in its higher position.

FIG. 9

This is a sample of photographs that are taken to impress upon the foreman the reasons why certain methods are wrong. For example, this picture shows two Gilbreth tables resting on their long side at their low height, so fixed that they can be picked up by booster trucks. The in-and-out bins are not the same size. The outward one is considerably too high to be convenient for the worker, and the worker is provided with a box instead of a comfortable stool.

of single choice, that is, his either standing or sitting, arrange the work so that he does it sitting, and does the necessary standing or moving about during his rest periods.

The change in industrial conditions has made this problem important. The question once was, "*Can* we make it of a quality that will pass?" Since the day of intensive outputs, the question has become, "*How many* can we make of a given quality?" In the first case, any kind of work-bench was good enough,— the worry being limited to the question of "*Can* we make it?" Now it is no trouble to make almost anything; but the worry is "Can we make enough so that the cost will enable us to pay the required wages and still compete, or must we give up manufacturing in this location?" This makes us think of the least fatiguing conditions and of making work-benches of two levels, etc.

The Chair or Other Fatigue-Eliminating Device.

Closely related with the work place is the work chair. It is distinct from the rest chair in that it is specially devised to be used during work periods. The ideal work chair is of such a

height that the worker's elbows will bear the same relation to the work place when he is sitting as they would if the work place were properly adjusted for him to do standing work. Types of chairs that have been designed and that are proving effective in eliminating fatigue while at work will be described more at length in the next chapter. The important point to be considered here is to adjust the work to the worker if possible. Where this is not possible, immediately, adjust the worker as best you can to the work. Make the relation of his elbows to the work the deciding point. If at present the work must be done standing, and the worker is too small, and it is easier to raise the worker than lower the work-bench or table, provide some sort of a stand or platform that will put him at the proper level. If he is large, raise the work-bench by lengthening the legs, or adding a false top, or, in some rare cases, by lowering the standing place. If the work is seated work, adjusting the chair will probably be the simplest change to make. Arm rests often afford an immediate and immense relief, but must fit the particular arm and be adjustable for best results. A head-rest may also

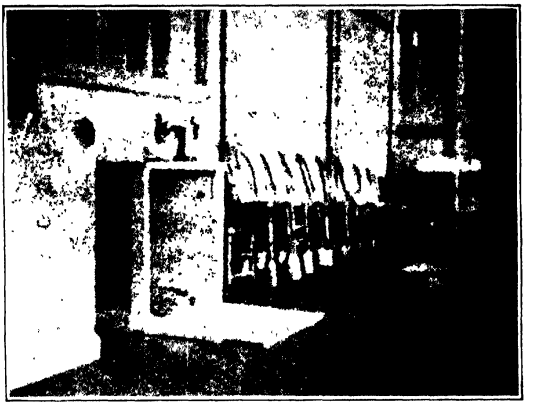


FIG. 10

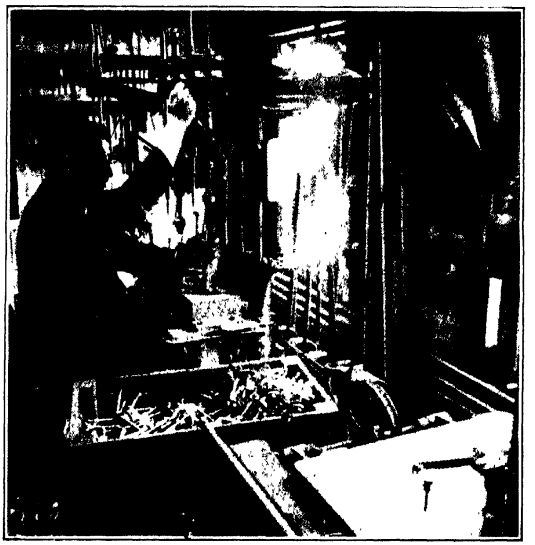


FIG. 11

FIG. 10

Very few people realize that the working girl should be measured for her working chair in which she spends one-half of the time that she is awake during her entire working life. For this purpose we have had testing chairs of varying heights made for the girls to sit in, and then have made a chair for each girl, particularly adapted to her and her work. The correct height of chair is determined much quicker and fits much more accurately than does an adjustable chair.

FIG. 11

This picture shows a worker seated at standing height operating a drill press. The pieces arrive in his inward box by means of a small belt conveyor that transports finished pieces from the machine that performs the previous operation.

be a valuable first aid, though often a later improvement in working methods will eliminate so much eye and head fatigue that the head-rest will not be needed. In other types of work, the foot-rest will often do the most immediate good. If every manager were made to sit for a certain number of hours to-day with his feet hanging, there would be an enormous increase in the number of foot rests in our industrial plants to-morrow morning.

Placing the Material Worked On.

In cases where it is difficult to readjust the work place, much fatigue may often be eliminated by placing the work in a better position. In fact this aspect of the problem should always be considered along with the readjustment of the work itself. For example, in folding handkerchiefs, a folder may be seated at a table, folding directly on the table. The table may be too low for the work. If she is given a board upon which to fold, this may not only put her work itself at the proper height, but it is also possible, with trifling added expense, to provide her with a table in two adjoining sections at two different

heights, and a sloping board that will make the work less fatiguing, as she can maintain a much better posture. She will also be enabled to put the finished product at a lower level. This will increase speed, while at the same time eliminating fatigue, which is, of course, an ideal condition.

In considering the placing of materials, we must consider also the manner in which the materials come to the worker and in which they leave him. Our later method study will make so many changes here that only very apparent, necessary, and inexpensive improvements should be made at this stage. Be sure, however, that you are using gravity wherever it can be used to advantage. Often we have found a small belt conveyor to be helpful in cutting down the hand transportation.

The Placing of Tools and Devices.

Gravity and mechanical means can be of use here, especially in carrying working equipment back to the place where it remains when not in use. Many preliminary improvements can also be made by standardizing the place where the

tool is to be left when not in use. There is not only the bodily fatigue of bringing the tool from a more distant place than is necessary, there is also the unconscious fatigue of constantly deciding such unimportant questions as where it is to be placed.

The Clothing of the Worker.

In an excellent series of articles on dress, published some years ago, Miss Tarbell laid down the rule that "suitability" is the final test of a costume. It is with this in mind that the clothing worn by the members of the organization while at work should be examined. It must be said, in the first place, that there is no more reason for the common custom of the worker providing his special outer clothing while at work than there is for his providing his other tools and equipment. In other times, the workmen of many trades preferred to provide their own tools, and did so, but in a scientifically managed plant to-day, the workers are provided by the management with standard tools. The management has standardized the best in a tool, and keeps it in the best possible working condition.

In the same way, it should be the duty of the management to provide special working clothes, when they have been standardized. This involves, of course, the problem of laundering, which may seem complicated to one who is not acquainted with what has been done in this field.

There has been very little done in most kinds of work to provide a costume, designed to conform to motion economy and least fatigue, that is, at the same time, useful, artistic, and pleasing. Progress has been rendered even slower by the fact that many workers have a prejudice against such garments, feeling that they show a class distinction. All that is necessary is to create a fashion of wearing such garments, like the fashion of wearing atelier or studio clothes. In no place can an example of unsuitable clothing be more clearly seen than in the laundry industry. Much of the work done in the typical laundry is done while standing, and the women who form a majority of the workers wear clothes, and particularly shoes that make the work far more fatiguing than it need be. Yet in this very industry some of the most progressive work to improve conditions is being done. In Europe a

shoe with a thick wooden sole and a heavy leather upper over the front part of the foot only is considered the most comfortable and least fatiguing. It is also certainly the cheapest and most durable. But Americans will not wear such a shoe. The shoe furnishes the most difficult feature of the costume problem. Here again the most important thing is that the "fashion" of wearing comfortable and efficient garments shall be set. We have hoped for years that sensible fashions in workers' clothes might be set by patterning after tennis or other athletic costumes, but the time when this will become general seems as yet far distant, due to the necessity of the worker using his oldest and discarded "dress up" clothes, ultimately for his working clothes. Nevertheless, the great loss in efficency, due to the general custom of wearing clothes that interfere with comfortable work, and that cause unnecessary fatigue, has caused us to start a campaign for the design and standardization of more suitable clothes. As yet we have had but few designs submitted in answer to our appeal to the worker to study the clothes problem for himself or herself. We are

making the same appeal to the management to suggest costumes for the approval of the worker.

In order that there may be no duplication, that we may pass on good ideas, we have started a little museum where typical fatigue-eliminating devices of all sorts may be gathered, and studied by any one interested. We must next describe in some detail what is and what is not as yet there, in order to offer definite suggestions for preliminary fatigue-eliminating designs that can be used from the first day of making changes.

Summary.

Preliminary fatigue elimination consists of improving lighting, heating, ventilation, fire and safety protection. It also consists of improving work places and work tables, of providing and improving chairs, and rearranging materials and tools, and studying the clothing of the worker. It aims to make immediate inexpensive changes before entering into an intensive study of the problem.

CHAPTER VI

THE FATIGUE MUSEUM: AN OBJECT LESSON

What a Fatigue Museum Is.

A fatigue museum is a collection of devices for and information concerning the elimination of fatigue, or for affording rest for overcoming fatigue. Its purpose is to serve as an object lesson as to how the fatigue problem may be approached practically. It aims primarily not to show beautiful exhibits, but to show devices which have actually done service. Many of these bear the marks of clumsy workmanship and hurried and cheap construction. This is an advantage rather than a disadvantage. It shows that fatigue elimination does not demand a large expenditure of money, nor depend upon having at the beck and call highly skilled mechanics to make the devices. Some of the exhibits have the excellent finish and the careful workmanship of the perfect product; but no

chair or piece of equipment, photograph, or drawing is too rough or too unfinished to find a place in the museum, if it contains an idea that actually may be utilized to eliminate or overcome fatigue.

The Parent Fatigue Museum.

The parent fatigue museum was in Providence, Rhode Island, and was started by us in 1913.

During the war, in 1917, the fatigue exhibits were presented to the Medical Museum of the Surgeon General's department at Washington, and it was expected that the Government would make a great exhibit of the horrors of unnecessary industrial fatigue from the standpoint of a national menace to the health, happiness, and future prosperity of our nation but due to such reasons as delay in starting the new building, for the much needed enlarged new museum, the retirement of Colonel W. O. Owen, the Director, who was specially devoted to its success and the fact governments move slowly even in most necessary good causes the National Fatigue museum is progressing so slowly that it looks to its originators as though it were either standing still or moving backwards. Meantime other

countries are taking up the subject of the Elimination of Unnecessary Fatigue, in earnest, and a literature is being written on the subject and the right result will surely come.

We find that the interest in the museum grows. Branch museums are springing up in different parts of the country. Every man at the second session of our Summer School of Measured Functional Management, which consisted of professors of psychology, engineering, and economics, volunteered to open a branch at his college. We are glad to have others who are interested, no matter what their field of activity, start branches also. All that is necessary to open a branch is to collect photographs, drawings, or actual examples of fatigue eliminating devices. Some of the college fatigue museums have consisted, until now, simply of such collections, though one college in particular has appropriated one hundred dollars, and is providing space for the exhibition of working models.

The parent museum is called Museum of Devices for Eliminating Unnecessary Fatigue, Number One, and the branch museums are numbered chronologically. There is no reason why

such museums should not be started in every factory, as well as in every college, and we are delighted to co-operate with any one who desires to start such a museum.

What the Fatigue Museum Contains.

The fatigue museum contains, at the present time, types of chairs, types of devices which hold working material in a convenient position, several assembly devices, several transportation devices, a work apron, and various drawings and photographs. It emphasizes, particularly, the chairs, as we feel that these are needed immediately and pressingly in all industries. A detailed description of the chairs will, perhaps, prove of most interest.

What the Museum Does Not Contain.

The museum contains, as yet, few exhibits, though we are expecting more in the near future. We are constantly impressed with the fact that it contains so few exhibits; this, in spite of the fact that we have sent out appeals since 1913, that have reached large numbers of people.

A short time ago we realized that the average

manufacturer had never thought of his work in terms of fatigue. We could, therefore, expect no fatigue eliminating devices, as he either had none to offer, or as he did not realize what he had. Again and again, a manager will say, in effect, "I am much interested in your museum, and should like to send you something, but we have never given much thought to the subject of fatigue elimination, and therefore, unfortunately, we have nothing that we can send." In many such cases, if we go through the plant, or the factory, or the store, we find fatigue eliminating devices, and immediately say, "There, that is just what we want." Whereupon the manager replies, "Oh, that. Sure enough it does eliminate fatigue. I had never thought of it in that light. We have always had that" Within the next few days we add a specimen to our collection.

We have, perhaps, not sufficiently emphasized the fact that eliminating fatigue means not only that we know the things that we lack, but also that we appreciate and fully utilize the things that we have. It is good practice to use what is on hand before laying in new devices. There

is waiting space, then, in the museum for any sort of device, old or new, well-known or not known at all, that does, or will, or may eliminate or overcome fatigue. There is an especially warm welcome awaiting any such type of stool or chair. The older and more worn it is the better, if it is still in working condition. There is a chance to be a pioneer by exhibiting clothing that is artistic, inexpensive, and appropriate for doing any type of work with less fatigue.

Types of Chairs and Their Uses.

We are fortunate in that, of the nine chairs exhibited, each represents quite a different type. This illustrates the large field for chairs.

Chair No. 1 is designed for work to be done standing or sitting. This is the ideal fatigue eliminating chair, as it allows of the most scientific distribution of work and rest periods, and for the greatest variation in working periods. The work for which this chair was devised was the folding of handkerchiefs, work that had always been done sitting. This chair is the result of accurate measurement, and is of exactly that height that will permit the girl's elbows to be

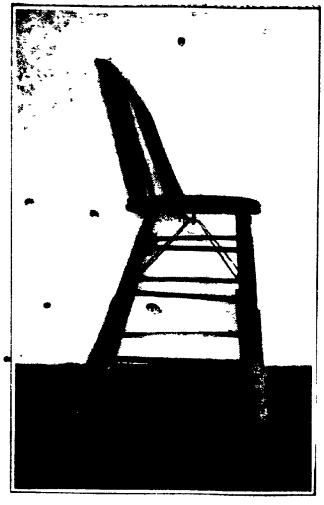


FIG. 12

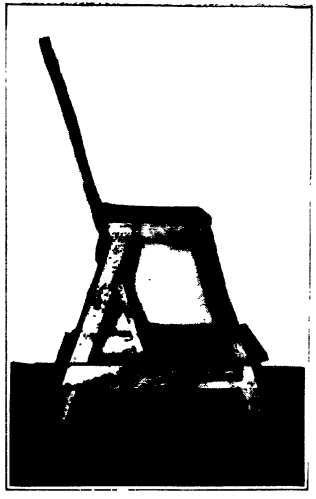


FIG. 13

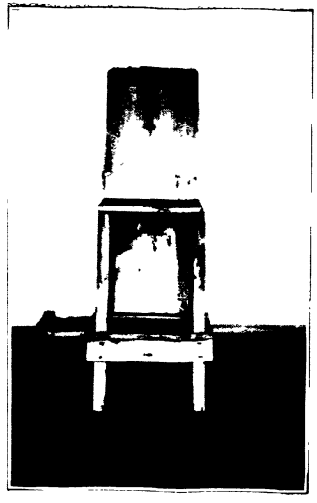


FIG. 14

FIG. 12

This chair is of type one, devised for doing work that has always been considered sitting work, either standing or sitting. In this case an ordinary chair has been boosted so that a worker can sit at a work-bench made exactly the right height for standing work. The chair is provided with ball-bearing casters, so that it can be pushed out of the way or pulled into position with little effort. This device helped make it possible to divide each hour into work periods and rest periods; and at the same time into standing and sitting periods,— thus not only eliminating unnecessary fatigue, but providing an efficient means for recovery from necessary fatigue.

FIG. 13

This chair is of type two, devised for doing work that has always been considered standing work, either standing or sitting. By its use, heavy filing can be done with greater ease and with the same speed and efficiency. The chair is inexpensive and easy to construct, and is of such a height as best suits the individual worker.

FIG. 14

Another view of the chair as shown in Fig. 13. The projecting foot-rest on this chair enables a man to push the file as efficiently and more comfortably seated than standing.

at the same distance from the work table when she is seated as when she is standing. The back of the chair, like the backs of all chairs designed for eliminating fatigue while working, is designed for work and not for rest. The chair is provided with dome casters, which allow of its being pushed away, or drawn back into position with the least amount of time and effort possible. The worker on this chair has a foot-rest which is a part of the working table.

Chair No. 2 is devised in order that a kind of work which has always been done standing may be done sitting. The work is heavy filing done at a vise, and the chair is provided with a projecting foot-rest. The work-bench is of such a height that the man may work either standing or sitting. In actual practice the filer works half of the time sitting, and half of the time standing.

Chair No. 3 is designed to eliminate vibration of floors that carry much high-speed machinery. An ordinary chair is provided with springs, that relieve the operator of one hundred per cent. of the vibration of the floor. This chair was designed for work at a machine, and the operator is provided with a foot-rest, which rests on felt

to kill the vibration. Note also the verandas on two sides of the chair for foot-rests.

The fourth type of chair is also a shock absorbing chair, which is more complicated in its construction.

The fifth type of chair is designed for school work, and has a rest for the right arm that may be lowered or put in place.

The sixth type of chair is a modification of a chair already in use. A chair which was once, perhaps, fairly comfortable has become worn off from years of use. This is rectified by boring holes in four small blocks of wood, and fitting them to the legs of the chair, which brings the chair back to its originally desired height. A well-known Middle West manufacturer used iron piping for the same purpose as the four blocks of wood. This is, in some cases, easier to secure, although not so good for the shop flooring.

A seventh type of chair is an adjustable, telescopic stool, which the inventor claims is adaptable to both factory and office work. This is admirable in that it allows of the chair being adapted to some degree to its user at the expenditure of little time or money.



FIG 15



FIG. 16

FIG. 15

A worker using the filer's chair, shown in figures 13 and 14.

FIG. 16

This chair is of type three, designed to eliminate fatigue from surrounding conditions. An ordinary chair, which was fairly useful and comfortable, was provided with springs that relieved the operator of 100 per cent. of the vibration of the floor. It is to be noted that the device attached to the chair is extremely simple and inexpensive, while at the same time it solves a problem that has always been rated as most difficult.

The eighth type of chair is devised for rest periods. We have two examples of this. One is a small folding stool contributed by a local drygoods merchant, much interested in fatigue elimination, who, as a result of our fatigue eliminating campaign, has installed many of these stools in his large store. The other is a more complicated chair with adjustable seat and back. This is designed not only for causing least possible fatigue, but also in the interests of correct posture of the user.

Four of the chairs show particularly what can be done with little expenditure of time or money. Only the filing chair is a "new" chair, in the sense of the entire chair having been made especially with the idea of fatigue elimination. The other three chairs consist of chairs already in use, supplied with cheap adjustments, made of material already at hand. These may impress the reader as extremely inartistic. This they undoubtedly are, but these are chairs of the transitional period, made to better working conditions immediately, and to be used until standard methods are introduced, and new standard fatigue eliminating devices substituted. It

must also be noted that three out of the four chairs are provided with what are practically footstools, although only one is shown in the picture, as only one is attached to the chair itself. The fourth chair allows of the feet being placed comfortably on the floor.

Other Fatigue Eliminating Devices.

The other fatigue eliminating devices exhibited are useful more as suggestions than as object lessons. There are various type of packets upon which materials are so placed as to be most handy to the worker. These packets are filled by unskilled, that is to say, young, or inexperienced, learning or unskilled workers in such a way that the material can be removed from the packet by the high-priced man with the least amount of effort possible. Filling the assembly packet is an excellent training to the unskilled worker, as will be shown later. One of these packets is contributed by a local manufacturer of cotton cloth.

The other devices for holding materials in position consist of two devices for holding motion picture films in position so that they may be studied with the least amount of effort possible.

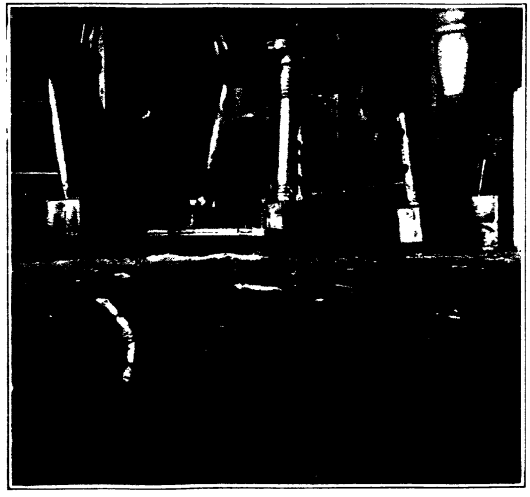


FIG. 17

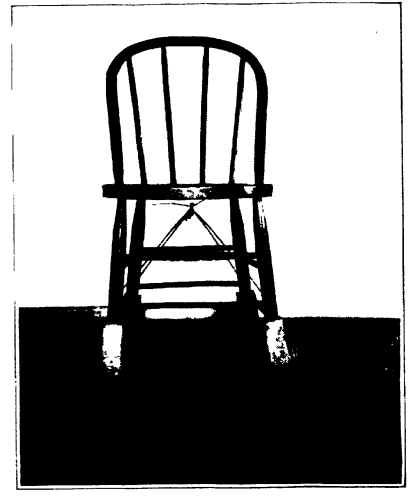


FIG 18

FIG. 17

These chairs are of type four, devised to relieve fatigue caused by vibration. Besides the chairs, foot-rests were devised to hold the feet without any vibration from the floor; and, also, special treadles.

FIG. 18

This chair is of type six, which modifies a device already in use, so that it will become a more efficient device for eliminating fatigue. The chair shown was, ordinarily, fairly comfortable, but the legs had become worn with time. It has, as shown, been raised to that height which is most comfortable for the worker. The work-bench, in this case, could not be raised so that the work could be done either standing or sitting. The problem was to have the sitting work done with the least unnecessary fatigue possible.

The transportation devices illustrate the principle of gravity, and also the principle of constant and careful adjustment of the transportation to the worker.

How to Use the Devices.

The devices of the fatigue museum are useful rather as suggesting devices than as object lessons. If your problem is to enable seated work to be done standing, raise your work-bench to the standing level, and put your work chair on stilts with casters, provided the work is not of a kind that requires a chair against which one can push. If your problem is to enable work that has been done standing to be done sitting, construct a chair that will bring the worker to the desired height. If your problem is to reduce vibration, put springs under the four legs of your chair. If your problem is simply to make sitting work more comfortable, be sure that the chair is of the proper height; that the seat slopes right and has a rounded front edge; and that, if it has a back, it is one that does not interfere with work. If the chair is too high, saw off the legs; if too low, add wooden blocks. Chairs of this type, as actu-

ally used by the workers, will usually offer suggestions as to what needs to be done.

In many factories one is astounded to find books, cardboard, cloth, blocks of wood, almost anything heaped in the seat of a chair to make the chair higher. Wherever workers are seated at a work-bench that is not adjustable, look for trouble with the chairs; that is, a tall girl crouching in a kindergarten chair fit only for a child or a dwarf, a short girl balanced on a high stool at a high table, without a proper place to rest the feet. No matter what the height of the table or the chairs, if many workers are seated at the same table, and the chairs are not adjustable, there is field for study. If workers vary much as to height, they should be sorted for height, and sent to tables with adjustable height legs; or, if workers cannot be sorted, the short ones should be provided with platforms to bring their elbows to the right height to fit the table, which should be adjusted to fit the tall workers. If your problem is to make sewing work more comfortable, and a chair seems impracticable with the methods used, perhaps a chair or some kind of seat could be provided for rest periods.

Starting Your Own Fatigue Museum.

We advise every employer to set aside a small space and assemble at least one example of each type of fatigue eliminating device actually in use, or that may suggest a device to be used. In the absence of a regular motion study man assigned for the purpose, the ideal state of affairs would be to have every member of the management walk through the factory once and look at present fatigue conditions in order to see what improvements could be made. This, however, is almost too Utopian to hope for.

It is the exception where the worker in any large plant knows intimately any part of the plant except the few little work places where he has toiled. A girl who had worked for years in a cotton mill, and who finally went into household work, begged to be taken on a visit of inspection to the factory. "But," said the woman who was to make the inspection, "I thought you worked there. Surely, you must know about the factory." "No, indeed," said the girl, "I never went anywhere except to get into the room where the machine was that I tended." Even in one

excellently managed plant where welfare, or betterment, is a prime consideration, a girl in the office department had never once been out into the plant itself. There is an enormous amount of educational work, that is also fatigue eliminating work, to be done in putting each member of the organization in touch with the entire working plant. There is not time or space, however, for an extended discussion of this problem here.

Therefore, until the workers can be taken to see the fatigue eliminating devices in actual operation, collect such devices, or photographs of them, and put them all in one place. Start a little fatigue museum of your own, even if it is limited to a properly labelled scrap-book of pictures always ready for inspection, and observe the effect upon management, workers, and invention in general. This effect will be reflected in the suggestion box, which in itself provides a unit of measurement of the progress of the fatigue eliminating campaign. When fatigue elimination has progressed to this stage, when actual devices are being installed, when the entire organization has come, as it will, to think in terms of fatigue elimination, the problem may be at-

tacked scientifically. This, the scientific elimination of unnecessary fatigue, is the subject for discussion in the next chapters.

Summary.

A fatigue museum is a collection of devices for eliminating or overcoming fatigue. The parent museum was in Providence and aimed to exhibit such devices as object lessons, and to encourage the spread of fatigue study by sending photographs with descriptions to all who are interested enough to start museums or even a scrap-book for pictures of devices for the elimination of unnecessary fatigue in the industries. Our fatigue museum specializes on chairs, but welcomes devices of any kind. It advocates the establishment of similar museums in colleges, or other institutions, and also in industrial plants and work places of all kinds.

In 1917 our fatigue eliminating exhibits were given to the American Medical Museum at Washington where it was thought it could do the most good.

CHAPTER VII

FATIGUE MEASUREMENT AND FATIGUE ELIMINATION: HOW TO ATTACK THE PROBLEM SCIENTIFICALLY

History of Fatigue Measurement.

Accurate fatigue measurement is in its infancy as applied to the industries. Such measurement can take place only where there is complete co-operation between the man measured and the man making the measurements. With the co-operation, that is the natural result of measured functional management, comes the possibility of making accurate measurements of fatigue under either laboratory or shop conditions. It is as easy to pretend to be tired as to pretend to be working. There is little or no profit in measuring pretended states. Under this scientific form of management there is no incentive to pretend anything. The incentive is, rather, to show exactly what one is doing and how one feels, in

order that accurate records may be made, and that the offered rewards may be received. We have, then, at this stage, where every member of the organization realizes that co-operation is necessary for the good of all, the opportunity to measure fatigue with considerable accuracy.

We have also the means. The psychologists and physiologists who have measured fatigue rely almost solely upon output as the unit of measurement. Decrease in output in a comparable unit of time, and all other working conditions remaining the same, is taken as indicative of being the result of fatigue. The observed man who is measured may add introspections, he may tell how he feels while working and at the close of work; but this testimony of his, while interesting and worthy to be recorded with the other data, cannot be submitted to the accurate measurement of the observer. In applying fatigue measurement to the industries in the same way that we measure activity and what it produces, we try to discover at the same time the condition of the worker by his own accounts as to how he feels. We have not only conditions under which scientific observations can be made and a method

of making them, we have also devices for measuring both activity and output and relative rate of output.

Fatigue, a Test of Efficient Activity.

As for the relation between fatigue and activity, practically all of our knowledge of fatigue is derived from our knowledge of the activity that produces it. We measure the activity itself, and its product. We then measure the interval of time that elapses before the organism has gained enough activity to perform the same work in the same amount of time and with the same results. A study such as this cannot extend over a short space of time only. It must be carried on until any fatigue that is accumulated shows itself; but it is simply a question of extending the time over which the experiment stretches, and of varying the length of rest periods until the desired information is recorded in the data. As we come to compare various activities and their results, we find that the fatigue is a measurement of the efficiency of the activity. If two methods of doing the same piece of work take the same amount of time and produce the same amount of

output, and if the interval needed to recover from the second is longer than that needed to recover from the first, then, other conditions being equal, the first method is the more efficient. A close study of the variables that affect the two methods will be necessary to show exactly why the first method is more efficient than the second, but the excess fatigue certainly shows that it is more efficient.

Fatigue can, then, be looked at in two ways:

1. As a product of doing work.
2. As a test of efficiency in doing work.

The amount of work done and the product are affected by various elements which affect the activity.

The Activity.

The activity is affected by the amount of practice that one has had. It is affected by the extent to which the action has become a habit. It is affected by the degree with which one has got into the swing of the work. This may be an individual difference. Some workers find it possible to start at work at very much the pace that they will use when they are well into it. A large

number of our records shows that most workers never get into the swing at the beginning of a work period. Not only the hour of the workday, but the time in the work period will have a strong effect upon the amount of work turned out. Again we have the question of spurt, when for some reason or other the activity is being performed at a pace that is above the normal pace. The effect of all these elements of the activity upon the fatigue itself depends upon the relation between mental fatigue and bodily fatigue. This relationship must be worked out by psychologists and physiologists. It is for the observer who measures fatigue in the industries to attempt to discover, as far as he can, what fatigue exists, and why it exists, and then to make both physical and mental conditions under which the activity is carried on as favorable to efficient activity as possible.

Motion Study, Micromotion Study, the Cyclegraph, and the Chronocyclegraph Method as Measurers of Activity.

We measure activity in two ways:

1. By motion study, which records in great detail the methods used in doing the work.



FIG. 19

FIG. 19

This picture shows the examination of the original micro-motion films at the motion study laboratory of the New England Butt Company.

2. By records of outputs when using the various methods.

Motion study consists of dividing the activity into the smallest units possible, measuring the variables of these units, studying the data, and deducing methods by which the activity may express itself more efficiently. Motion study, whatever its type, implies time study, in that the time the motion occupies is one test of the efficiency of the motion.

Micromotion study is the name we have given to our method of recording motions and their surrounding conditions by means of a cinematograph and one of our special clocks which registers extremely small intervals of time, smaller than the elapsed time between any two pictures of the cinematograph film. The micromotion method enables us to record easily motions down to less than a ten-thousandth of a minute. This gives us all the information we could desire for purposes of time study, and the record is absolutely free from the errors in time due to the personal element. Although many of the various elements, or units, that comprise the path of a complete motion, or cycle of activity, ap-

pear on different pictures in the film, it is difficult to visualize or measure the orbit or exact path of the motions by means of the film.

The cyclegraph method permits us to record, measure, and see this orbit or exact path of a motion or cycle of motions. Small electric lights are attached to the hands, or any other members of the body involved in the motion. A photographic plate or film is then exposed while the motion is made, with the result that a path of light, which resembles a white wire, is seen upon the developed plate, representing the path of the motion. The effect is best gained by a stereoscopic photograph, which shows this path in three dimensions.

The chronocyclegraph method enables us not only to see the path of the motion, but also its directions, and the duration of the entire motion and of its elements. These chronocyclegraphs are made by attaching lights to the moving parts of the body, or machine, as in the cyclegraph, and by introducing a properly timed, pulsating interrupter in the circuit, which may be adjusted not only to record the time and duration, but also to record these with different graphs, repre-

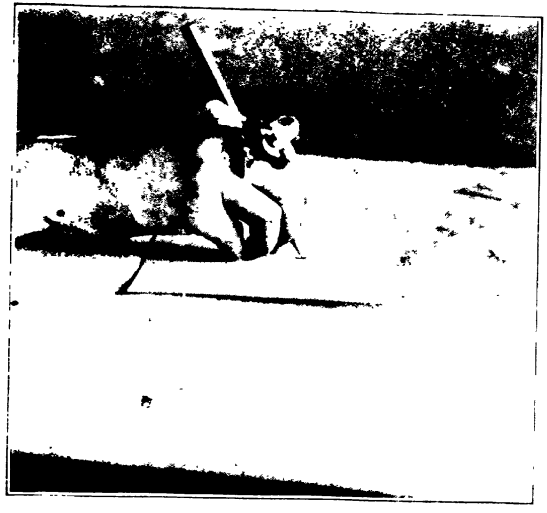


FIG. 20



FIG. 21

FIG. 20

This picture shows a lamp attached to the hand for the purpose of taking cyclegraphs or chronocyclegraphs of motions in connection with obtaining motions of least fatigue.

FIG. 21

This picture shows an experiment that was carried on by us some time ago for determining the laws pertaining to the times and fatigue of motions of different lengths.

The operation studied is that of moving a seven pound weight. The times are divided into three parts: Length of time from starting to picking up weight; length of time from picking up weight to depositing; and length of time of recovery to standing position from depositing. The experiment proved that the time of motions of different lengths is practically the same unless those of the same length are consecutively repeated. The quantity of work that can be done in a day is, of course, much less with long motions than with short ones, due to extra time needed to overcome the fatigue of the long motions.

senting the paths of each of several motions made by various parts of the body and their exact distances, exact times, relative times, exact speeds, relative speeds, and directions.

By means of the "penetrating screen," it is possible to pass a cross-sectioned plane in any direction through any desired plane, or through any number of planes in the cubic space under observation. This makes it possible to record the data with great accuracy in three dimensions, and to read the information from the data easily.

These various types of motion study supplement rather than supplant one another. Motion study is primarily for the purpose of observing the variables that affect such study, and for arousing such co-operation between observed and observer, as will make possible the testing of the differences of the effects of the variables. Micromotion study provides for an accurate record of what happened, with all such attending circumstances as appeal to the eye. It is the greatest aid in transference of skill and experience from a worker who has it to one who does not possess such skill and experience. The cyclegraph is

useful in providing a simple, easily understood record of the path that any activity followed. The chronocyclegraph is most valuable when the activity is complicated, and when the time and direction of the elements of the motion must be visualized continuously in order to analyze, measure, synthesize, and standardize the process. The penetrating screen, finally, is useful in recording the three dimensional paths and speeds of even the smallest unit of activity.

These methods of applying motion study have been patented, but have been for years freely at the disposal of the colleges, which have begun to use them as means for recording accurately scientific data of various kinds. They have justified themselves as more accurate than ordinary records of activity, and have within recent times been put on a basis which makes their cost compare favourably with less accurate methods of measurement. What is more, we have discovered in our data, especially in the chronocyclegraphs, direct records of fatigue, that we believe are the first records of fatigue ever made under industrial conditions. The micromotion films also show breaks in well established habits of



FIG. 22

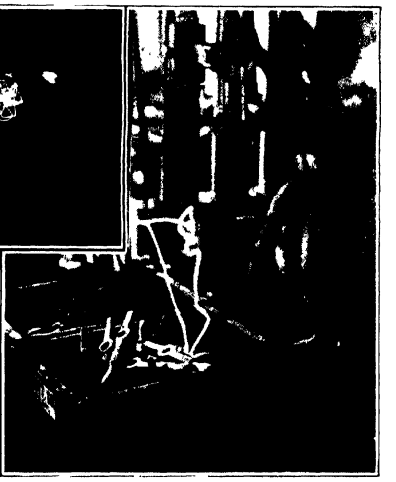


FIG. 23



FIG. 24

FIG. 22

Typical chronocyclegraph of the motion and fatigue study of a bricklayer, laying three brick in the old method.

FIG. 23

Typical cyclegraph of motion and fatigue study on a drill press, showing cyclegraph of path of motions of the left hand.

FIG. 24

Typical chronocyclegraph of compositor setting type by hand.

several motions that are undoubtedly due to fatigue, but the irregularities in the orbit line, that appear in the cyclegraphs, and that must, because of close control of the variables, be due to the fatigue alone, are more impressive from the physiological viewpoint.

Testing the Work by Motions Required.

It is for motion study to explain the methods of deducing standard methods by using activity records obtained through the various types of motion study data. Many such standards have been derived. We have in our motion study data many elementary motions with records of the space they cover and the amount of time they require. With these we can test the given work to see which of these motions it includes. Having tabulated this, we can make an intensive study of the motions that remain. When this study has been made, we can combine the resulting elementary motions that have proven themselves most efficient into the working method, and classify the work as work of a type requiring a certain set combination of motions.

Testing Workers by Motion Capabilities.

In the same way we may test a worker by motion learning capabilities, before assigning him to any kind of work. Having reduced activities to their motions, we can test the worker's physical capability; his mental capability we can test by determining his learning curve. To these results we add a record of his interest in various types of work. From the resulting three types of records, we can make placements that, we believe, are far in advance of any that have been made up to the present time.

The Use of Activity Records as Data for Eliminating Fatigue.

The fact that activity records are made of extremely small elements moving through a short path in a small amount of time means that the fatigue records cover the same short periods. This is a great help in making fatigue study. A new combination of elements of activity will also mean a combination of concurrent, or included, elements of fatigue. The combination may have some effect on the activity. If so, it will also affect the fatigue, but at the present state of the

art the most accurate and satisfying work can be done by making use of activity records to eliminate unnecessary fatigue, without waiting for some hypothetical, direct records of fatigue, that may be worked out in the future. In other words, if you have accurate records of fatigue included in your activity records, use these immediately, without attempting to make separate records of the fatigue, that, while valuable, will mean delaying fatigue elimination, perhaps indefinitely.

The Time Element.

Too much credit can never be given to Dr. Taylor for his emphasis on the laws of the time element. He was the first to call to our attention the fact that operations should be divided into the smallest possible, timable units for setting tasks. In this way it is possible for timed elements to be used in many combinations, thus eliminating an enormous amount of unnecessary work. Dr. Taylor also recommended that work periods should be timed separately from the rest periods. Our new measuring devices for time study make it possible to record much shorter intervals of

time than were heretofore known, and now the limiting factor in the problem is no longer the quickness with which we can use a stop-watch.

Our methods and devices have been criticised as being specially adapted to problems involving the minutia of motions, but too expensive for the general time study purposes. A moment's consideration will show that the turning of the crank of the cinematograph may be done as slowly as the requirements of the particular case of time study demand. In fact we have films that were taken at the rate of one picture every ten minutes. With the sixteen pictures to the foot, a foot will last one hundred and sixty minutes, or two hours and forty minutes, at a total maximum cost of six cents. If desired, the speed of the crank can be instantly changed to any desired speed to enable one to take pictures too quickly to be seen with the eye, and more accurately than the highest-priced time study man can take by means of a stop-watch.

Our methods, devices, and records of activity and of output fulfil every requirement, and are now perfectly satisfactory. Fatigue still remains the elusive factor. Nothing but long-con-

tinued observation, absolute accuracy and co-operation between all interested will reduce fatigue study to the science which motion study has become.

The Standardization of Work and Rest.

Meantime, in standardizing work and rest periods, it is customary and proper to make a larger allowance for fatigue than the records show to be necessary. We cite as an example a case of folding handkerchiefs. The old method of folding was to have the workers seated at low tables in chairs of ordinary height, working throughout the entire day, with the only rest periods an hour at noon and such ceasing from folding as took place when the workers went for supplies, or took back finished product to be checked, or other rest periods that they took at will, as the work was piece work. After an intensive study of the problem, made not only to increase their output but to better their working conditions and allow them to earn more money with less fatigue, the following schedule of work and rest periods was adopted.

Each hour was divided into ten periods. The

work was placed on a work table of the proper height. The handkerchiefs already folded, those being folded, and those to be folded were arranged in the most convenient and efficient manner. All variables of the work had been studied, and the results of the study standardized. The first four periods, that is, the first twenty-four minutes, the girl remained seated. She worked five minutes and rested one; again worked five minutes and rested one. That is to say, she had four minutes' rest out of the twenty-four, and spent this rest seated so that she might lose no time in getting back to the work. The next two periods, that is for twelve minutes, the girl was standing. Again she worked five minutes and rested one minute, and for the second time worked five minutes and rested one minute. That is, she rested two out of the twelve minutes in the same position in which she worked. The third group, a space of eighteen minutes, she spent either sitting or standing, as she pleased. Here also she worked five minutes, rested one minute; worked five minutes, rested one minute; worked five minutes, and rested one minute in the position, either standing

or sitting, which she herself had chosen. The last period, which consisted also of six minutes, was spent by the girl walking about and talking, or amusing herself as she otherwise chose. With this might be combined the last rest minute or period No. 9, which thus gave her seven consecutive minutes for unrestricted rest activity.

This was the schedule for all hours of the day except the hour before noon and the hour before closing time at night. In these hours the first nine periods resembled the first nine periods of the other hours; but the tenth period was spent in work, as a long rest period was to follow.

At the end of the day's work under these conditions the girls accomplished more than three times the amount of their previous best work, with a greater amount of interest and with no more fatigue. It may be stated here that the primary aim in this investigation was not to eliminate fatigue, but to increase the wages of the girls by raising the output. The operators had not seemed overfatigued at the start. They maintained that they were less tired at the close of the day when using the new method, and certainly the amount of fatigue caused by producing

an amount of output such as was made under the old method was reduced to an enormous extent. With further practice these preliminary results will be further improved.

It is of fundamental importance in making an investigation of this type that the allowance for fatigue be greater than the physical condition of the worker at the end of the day seems to indicate necessary. It is also fundamental that the results of the investigation be at once incorporated into actual shop practice. If each member of the organization is at once placed under such working conditions that he can enjoy the rest periods along with the high pay that comes from a large product, he will co-operate most fully in the progressive work of fatigue elimination. It is a fundamental rule of scientific management that the rate once set must never be cut. It should also be a fundamental principle of our management that rest periods once established should not be abolished or shortened. Let the error, if error there is, always result to the advantage of the worker, never to that of the employer. If you have not allowed enough rest, make the allowance larger, then reinvestigate.

If you have allowed too much rest, let the job stand as one to be given for special merit, and attack some other problem. The result will be an increased co-operation which will more than compensate for the occasional over allowance for fatigue.

Summary.

Fatigue measurement, as applied to the industries, is a new science. It is being developed through a study of the data of activity. The methods of measurement of activity are motion study, micromotion study, the cyclegraph, the chronocyclegraph, and the penetrating screen. Through the data derived by these, we standardize motion paths, motion habits, and all other motion variables. These enable us to test and classify, select and place, both work and workers, and to eliminate unnecessary fatigue. Through the time element we compare our various data, and finally arrive at results that enable us to standardize work and rest periods. Any errors in length of rest periods must result to the advantage of the worker.

CHAPTER VIII

MAKING ADJUSTMENTS: HOW PRESENT PRACTICE IS DEVELOPED INTO STANDARD PRACTICE

A Concrete Example of Making Adjustments.

In order to make plain exactly how changes are made and take place from the condition before analysis, measurement, and synthesis are made to the standard method of doing the work, we shall take a concrete example and consider it from every phase. This concrete example will be the assembly of a braider or machine for manufacturing braid, which is a standard product of the New England Butt Company. With the cooperation of Mr. John G. Aldrich, who has since become president of the company, the problem of assembling a braider was studied, both in the laboratory and in the shop.

'It is not generally recognized that ultimate standards can best be derived in the research room and laboratory. The standard practice in

the plant will be the result of the laboratory practice. If the finer measurements are made in the shop during the general working operations, much time will be lost, as shop conditions cannot be controlled as laboratory conditions can. It has been said that laboratory experimentation is not directly available in shop practice, because laboratory conditions differ from shop conditions. They certainly do differ, but so do the ultimate shop conditions that must be introduced with the new standard method. The ultimate conditions in the shop are far nearer the laboratory conditions than are the shop conditions prior to installation of the new methods.

Former Method of Assembly.

The method of assembly in use before the motion study and fatigue study were applied was as follows: The base of the braider was placed on an ordinary low bench, and the various parts were kept in tote boxes or on the floor. The worker selected such parts as he wished, and put the braider together according to any traditional method that he had learned, together with such changes as his whims dictated.

How the New Practice was Derived.

All of the previous assembly methods had been determined by the usual practice of putting braider parts *together*. In the present case the braider was taken apart; that is, handled in the reverse order of assembly, in order to determine from a new viewpoint the best method of putting the various parts together. The parts were laid out on a table in the sequence in which they were disassembled. This allowed the various members of the braider divisions, groups, and subgroups to be studied in relation to one another and also separately.

The Two Factors to Be Considered.

The problem resolved itself into two parts:

1. To make the table of the most convenient height and shape to hold tools and the base group as it grew, while being assembled.
2. To provide the most convenient, temporary, resting place for the tools and the various parts, before they were carried to the final position of assembly.

The two parts were so closely related that any

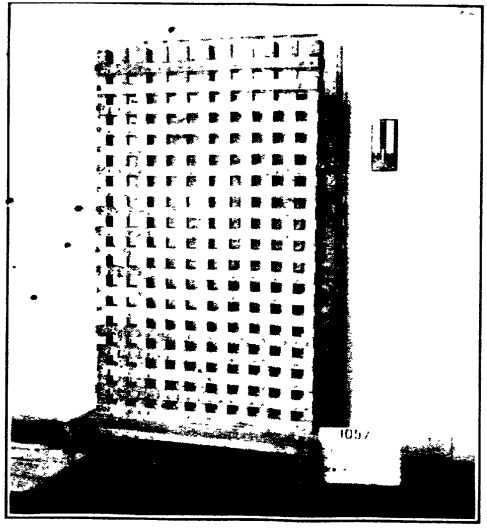


FIG. 25

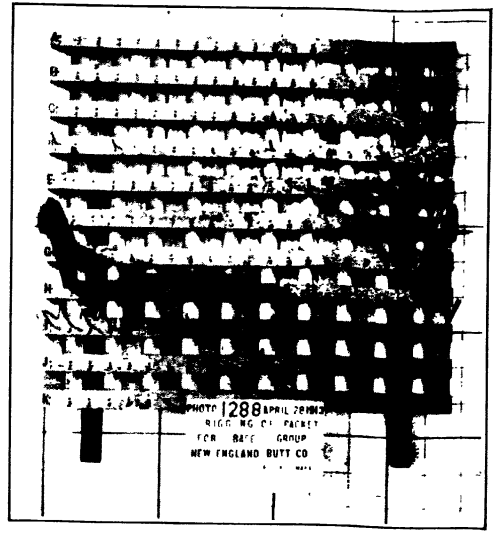

PHOTO 1288 APRIL 29 1943
RIGGING OF PACKET
FOR BAFF GROUP
NEW ENGLAND BUTT CO

FIG. 26

FIG. 25

Easel for simplifying motions and reducing fatigue from work of assembly. The obvious sequence in our packet method eliminates the delay and fatigue of the decision of choice.

FIG. 26

The rigging on a typical Gilbreth packet, as used for the assembly of braiders and cord machines at the New England Butt Company. This picture shows only the supporting devices. The length of the supporting devices is determined by what is to be held upon them. The right quantity of each kind, therefore, can be put on without counting. These devices are standardized and are but few in number. They are specially designed and arranged for picking up parts with both hands, simultaneously, in an obvious sequence with shortest motions and least fatigue.

modification in one demanded a modification in the other.

Outline of the Changes to Be Made.

It became apparent, as the work progressed, that the determining elements were (1) to shorten, as far as possible, the distance for transporting the arms and hands while loaded; (2) to arrange the parts so that their sequence of use would be obvious; (3) to position each piece so that it could be grasped, transported, and released in the shortest time with the least expenditure of effort and with the least resulting fatigue. This meant that the parts should be arranged on some sort of a holder, or packet, that would shorten the transporting distance, and that the base group should be placed upon a table that would carry it as near this packet as possible.

The Solution of the Problem.

A packet, which was practically a table with its top extending vertically, was placed near the table supporting the base group, and removable wire rods of the right length were placed in it to support the various pieces in the best position for

grasping. This also considered the shortest distance for transporting the arms and hands, whether empty or loaded. These table packets were then modified, following closely the principles of the design of the brick packet, especially the hand-hole feature for firm grasping with one motion and for quick counting of the number of pieces. The packets now consist of strips of wood two inches apart, horizontally, and two inches apart, vertically, with holes for pins. interchangeable wire rods, forked hooks, and other hangers, including interchangeable platforms, shelves, and vertical supports, extended and positioned for still shorter reach, and holding in turn such devices as pins to permit the best position for handful grasping without disturbing the motions of the hand or the wrist from the natural position, or, that is, the position most resembling that of normal rest.

The right position for grasping anything with least fatigue is that position that will permit grasping without turning, twisting, or holding the wrist at all from its natural resting position, that is, with muscles in natural balance. It is but natural that this should be the best way, for

it cuts out the positioning motions of the hand prior to grasping.

Two reasons that the strips of wood were made two inches apart, horizontally, and two inches apart, vertically, were:

1. Because we desired to get standard data at the same time comparable with our other standard data. We might also use it for checking, by means of motions in another trade, the underlying laws of motions, which we had already deduced in several other trades.
2. Because we desired to have the motions in very nearly the same places every time, in order to get the extra efficiency and the lesser fatigue that come from the habit that is formed in this reaching and grasping.

Many of these laws have since been re-checked and used in methods of least waste for the transference of skill from one trade to another. Habits have been formed that permit a much greater amount of output with less fatigue.

This latticed packet gives us the same dimensions as our cross-sectioned background. We use

four inches in our American work, and ten centimetres in our European work for these distances — the difference between ten centimetres and four inches being almost exactly one-sixteenth of an inch, or so small a difference as to be practically negligible in work on motion study.

This cross-sectioned packet has, therefore, not only many mechanical benefits, such as forming supports, either horizontally or vertically for hangers, but it is also cheap to build, light in weight, and forms an excellent, relative scale for measurement and for "recording the surrounding conditions" of a case of micromotion study.

In fatigue study, as in all other work of investigation, it is difficult to obtain assistants who can "observe what they can see." Of those observers who observe what they can see, few will write down what they observe. Of those rare ones who can observe and will always write down, few have the habit of maintaining the standard conditions in a long series of observations. We therefore cross-section the background, make our devices, when possible, multiples of four inches, and record the conditions by means of photogra-

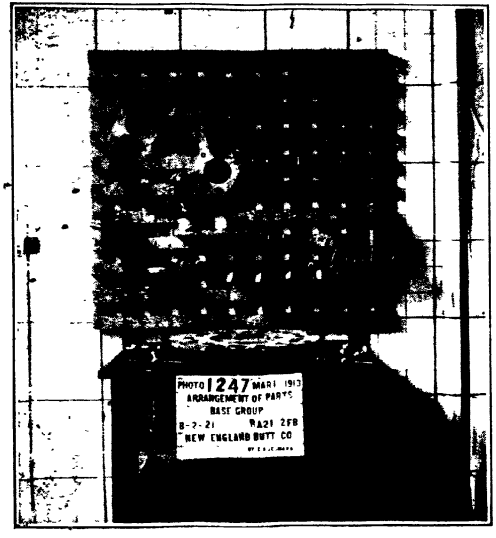

PHOTO 1247 MAR 1913
ARRANGEMENT OF PARTS
BASE GROUP
8-2-21 RA21 2FB
NEW ENGLAND BUTT CO

FIG. 27

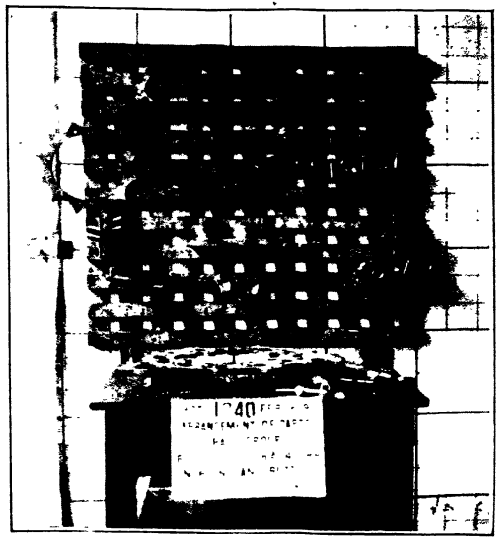


FIG. 28

FIGS. 27 and 28

This picture shows the arrangement of parts for the base group of the braider. It will be noticed that there are three adjustable shelves, two vertical and one horizontal, for the support in a more convenient position of certain parts that have to be picked up, for least fatigue, by handfuls at a time. The various kinds of shelves, clamps, and tables for different sizes or kinds of machines can be removed or attached to the packet with one motion of the hand.

Note that the top plate is in position and that the tools are at the right side of this top plate before the assembler is sent to the job at all. These parts are arranged in an obvious sequence, and a photograph similar to this is given to the boy whose duty it is to arrange these parts.

phy, that gives us the key to causes of deviation from class results.

The modification of the table consisted of making it of such a design that it could be turned over on its side to form a low table for tall or double-deck braiders, that would permit motions of less fatigue.

Final Adjustment.

In its final form the method consisted of having the parts of the braider placed on the packet by an unskilled laborer or boy, putting large tacks on the floor, which located the table at the most convenient point possible in relation to the packet, which was made fast to the wall or of easel type, on casters, as the position where it must stand demanded. In addition, a small gravity, Johnson-Littlefield packet was attached to the table. This conveyed certain parts, by their own weight, to a yet more convenient position.[1]

[1] The Johnson-Littlefield packet is a splendid example of the types of fatigue saving devices that are suggested by employees after they have been taught the underlying principles of motion study.

Changes in Type of Work Demanded.

Through this adjustment the assembler used only his most skilled motions in doing his work. Meantime, the less skilled worker, or apprentice, who was loading the packet, was learning the assembly principle, and receiving an apprenticeship in assembly itself.

Change in Mental Attitude.

The effect of the adjustment was to establish easily and quickly a new set of efficient habits. The parts being arranged on the packet in an obvious sequence, and the tools being arranged on the table in the standard position, the worker necessarily performed the work according to the standard method, which was the quickest and least fatiguing method, every time that he did it. The result improved his working method, and acted as an incentive to him to do the largest quantity of work of the best quality that could be done with a reasonable amount of fatigue.

Value of This Example.

This example is even more valuable as a method of attack in the adjustment problem than



FIG. 29

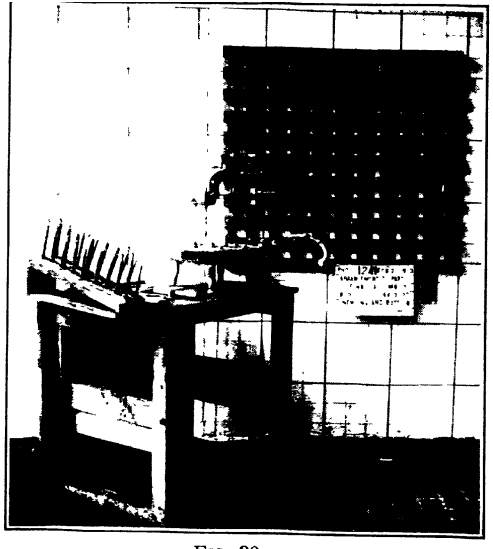


FIG. 30

FIG. 29

This picture shows a Littlefield-Johnson carrier packet. In this carrier packet the carriers by their own weight travel downward to a standard position at the bottom for grasping without looking at them, as fast as they are individually removed. This packet was invented by two men in the New England Butt Company, after they had seen our method of attack, and had begun to think of their work in the terms of elementary and least fatiguing motions.

FIG. 30

This picture shows a Gilbreth packet and a Gilbreth bench, arranged with the carrier packet shown in Fig. 31 for the assembly of a 13-strand braider.

it is as a specific illustration of a successful and rapid installation. The workers enjoyed the changes and accepted them in the best spirit of co-operation. Before using the method, eighteen braider base groups had been a large day's work, per man. With the new method, sixty-six, per man, per day, were assembled with no added fatigue. The resulting saving pleased every one concerned, and has assured the maintenance of the method. Like all other methods, old or new, it must be submitted to certain definite tests. These it has passed with credit. The outlining of such tests is our next problem.

Summary.

The problem of adjustment and its solution can best be illustrated by a concrete example. This is of changes made in assembling the base group of a braider. This example is valuable not only as an incidence of successful application, but as an outline of an efficient working method.

CHAPTER IX

THE OUTCOME: HOW FAR HAVE WE ATTAINED OUR AIM?

The Tests of General Health.

We will now assume that the reader has attacked the fatigue problem in his particular plant, and has applied either preliminary or more permanent fatigue elimination. There are various general measurement tests which he may apply to the results, in order to see how much better the working condition of his organization actually is than it was when he started in upon his fatigue-eliminating work.

The first of these is the test of general health. It is, of course, perfectly possible that an individual worker's general health may go down under far better working conditions; this, because of some home influence, or something in his general condition or his life away from work, which pulls down his health. It would not be fair to blame the work for any illness easily traceable to

home conditions, to an epidemic prevalent, or to some certain outside source; but, if conditions away from work have remained fixed, there is every reason to expect that general health should improve with fatigue elimination. This we find in actual practice is the case. Even where fatigue is not materially cut down during working hours, because measurement shows that the worker is not getting over-fatigued, the general health is apt to improve because of greater regularity in habits of work, and because of better physical and mental habits, while doing the work. The path along this line is a continuous, never-ending, upward spiral. Fatigue is eliminated by establishing proper habits. Proper habits improve health. The improved health allows of more work with less fatigue, etc.

The Test of Prolonged Activity

In order to be thoroughly satisfactory, observations of the effect of the changes upon the worker must be made during a long period. The worker's greatest asset is his ability to work. In order to prove its value, fatigue eliminating work must actually show results in prolonging

the years that he is able to devote to his life work. This in practice it does. Not only does the average worker remain physically able to work more years than where no fatigue elimination has taken place, but also through the fatigue study and motion study, which he has cooperated to make, he learns to be able to teach that thing, or those things, at which he is most skilled, and thus to prolong his years of economic value. You must note how many of your workers are beyond the usual working age, and are still at work. Some of these will be working at the work itself; that is, in the performing department. Others will be planning or teaching the work in some way. The number of these and their condition will form an admirable unit of measurement of the success of your work.

The Test of Posture.

The third test is that of posture. Take another walk through your plant, and look at those workers to whom fatigue elimination work has been applied, and note how they are sitting, or standing, or walking.

The American Posture League, with headquar-

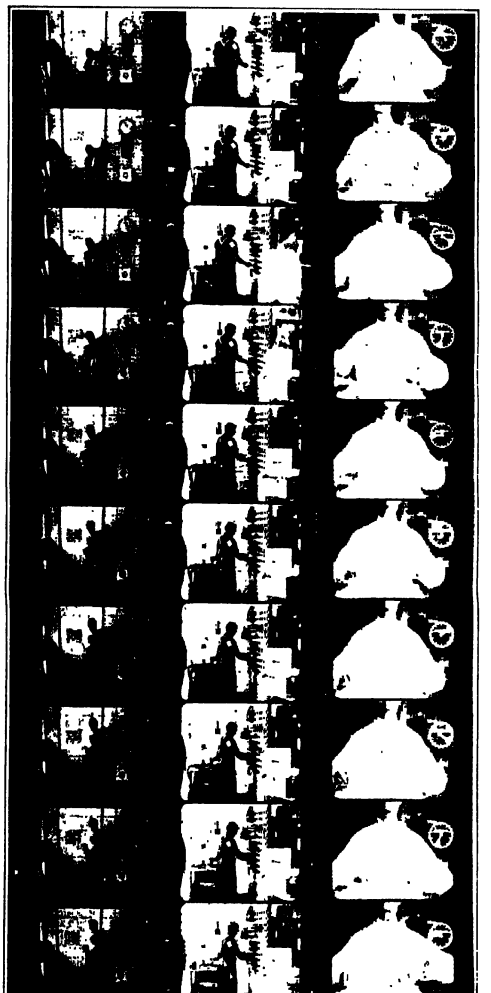


Fig. 31

FIG. 31

B. Micromotion of workman reaching with both hands for pieces of a machine which is being assembled. The microchronometer in the foreground registers divisions of time to the half a thousandth of a minute, and therefore gives us much data relating to time study, motion study, and fatigue study.

Set of experiments in fatigue study for proving that times of motions have little close relation to lengths of motions unless the same length of motion is repeated consecutively many times. (See Fig. 21.)

C. Penetrating screen in the plane of the motions for the purpose of registering exactly the distance of motions in fatigue study experiments.

ters at 30 Church Street, New York City, will gladly furnish standards for proper posture in various positions. It will be impossible, of course, to eradicate wrong habits of posture in a short time, no matter how radical the change may be, but you should note improvements. At least each worker should be so placed that he could work in the proper posture if he chose, and so that the proper posture will be the easiest for him. If the chairs, benches, levers, or devices force him to assume the proper posture, so much the better. Consideration of the devices shows, unfortunately, that few are designed for operation with least fatigue; more being designed to use the least quantity of material.

In the case of young workers, especially, it is surprising how quickly the proper devices will induce the correct posture, especially if the betterment staff co-operate to explain the correct posture, and its effect upon health. Where no betterment staff exists, the posters of the Posture League will serve as desirable examples and object lessons. Here again, as in so many other places, "fashion of work" is a most important element. Let correct posture become the fash-

ion, and let the devices make the posture possible, and astonishing results will follow.

It is, of course, always a great aid to make anything that one desires the easiest thing to do. The proper chairs and work places make correct posture the easiest posture to hold. This is a great force towards maintaining it.

The Test of Behaviour and Implied Mental Attitude.

The fourth test is to observe the behaviour of the workers. Do their actions, their resulting work, and whole attitude towards the work indicate that the fatigue eliminating work has been effective? There should be better "habits of work" than have ever existed before. More work should be turned over to the habit processes, and the formation and maintenance of good habits should become a part of the day's work. It should be noted just exactly what seems to be the kind and amount of incentive that keeps the workers at the work. If the fatigue elimination has done what it should along its line, the reason for doing the work as it is being done will be the belief that this way is the best way yet found, a

belief that one is safe in following the method, since proper allowance for fatigue has been made. There should also be present a desire to contribute to the welfare of all by looking for easy ways, as well as scientifically-derived ways, to eliminate fatigue, while at the same time following the best method as yet available.

The question of motivation is one demanding understanding and serious consideration in every field of activity to-day. This is true in education. It is also true in the industries. The motive of getting all that one can for one's work must always exist, and is a perfectly justifiable motive, but the fatigue-eliminating work cannot be considered successfully, unless this motive of self interest has also with it the motive of interest in the welfare of others, and in cutting out all fatigue that can effect any member of the group in any way. This feeling should express itself in a social attitude, which is another behaviour test. If every member of the organization stands ready to endorse the fatigue elimination, and to co-operate in further fatigue elimination for the good of all, the social attitude shows that the work that has been done is worth while.

The Test of Transference of Skill.

The amount of skill that is successfully transferred may be used as a test of fatigue elimination. Each member of the organization is supposed to transfer skill, and also to acquire skill. He transfers to others the skill in the lines of work in which he is proficient, yet which are not the highest types of work that he can do. He learns from others such types of work as are of the highest type that it is possible for him to learn, that he has never had an opportunity to learn because of the time taken by work requiring less skill, that it was necessary under the old plan for him to do.

It is a fallacy to suppose that work which does not demand all the skill at one's disposal is less fatiguing than work which does. Work is not less fatiguing because it demands less skill. It is less fatiguing when it is done with ease and when there is a joy of achievement requiring skill; that is, when it is satisfying. Because of lack of opportunity, one may only perform with ease the work which does not demand much skill. As soon as he learns to perform the skilled work with ease, it causes even less fatigue, other things

being equal, than does unskilled work, because it holds the interest, hence the attention, more easily.

We enjoy doing that which we can do well. Whether we improve in the doing because we take pleasure in doing it, or simply because the pleasure makes us do more, and we improve with the practice, is not of great importance. Psychologists are divided in their opinions as to the effect of pleasure upon work, but all agree that, directly or indirectly, pleasure in the work does affect the work favourably. Through the transference of skill this pleasure is given to the work, or increased in the work, and, therefore, the amount of skill transferred is a test of fatigue elimination.

Test of "Happiness Minutes," Individual and Social.

The final test of fatigue elimination, as of every other change made in doing things, is its influence upon the total output of "Happiness Minutes." The aim of life is happiness, no matter how we differ as to what true happiness means. Fatigue elimination, starting as it does

from a desire to conserve human life and to eliminate enormous waste, must increase "Happiness Minutes," no matter what else it does, or it has failed in its fundamental aim. Have you reason to believe that your workers are really happier because of the work that you have done on fatigue study? Do they look happier, and say they are happier? Then your fatigue eliminating work has been worth while in the highest sense of the term, no matter what the financial outcome. Naturally the savings that accrue must benefit every one, but saving lies at the root of fatigue elimination, and, if every member of the organization, including the manager and the stockholders, is getting more "Happiness Minutes," you surely are working along the right lines.

Social "Happiness Minutes" will consist of the sum of the individual "Happiness Minutes" plus that intangible thing called "social spirit." It is exemplified in a case like this: A certain group of workers had been studied from the motion study and the fatigue standpoint. The result of the work had been incorporated in their daily practice, and they had been working for a



FIG. 32



FIG. 33

FIGS. 32 AND 33

These pictures are of meetings of the Foreman's Club at the New England Butt Co. examining films of methods of least fatigue, proposed for standardization.

period of many months under the readjusted working conditions and with the new methods. At the end of this time they were gathered at a foremen's meeting, where a micromotion film, showing the development of the methods which they used, was presented. In discussing the film the speaker took the occasion to say that on observing the work in the plant he felt that some lapses from the method prescribed were in existence. The next morning, when he walked through the plant, he was stopped by a worker, who said, "See here! I don't believe we are falling away from that method a bit. If we are, just show us where, and we will go straight back to it. We want to play the game right." This is the test of the outcome. Is the organization lined up as one man back of the work? If so, the problem of maintenance and of automatic improvement is solved.

Summary.

At any stage in the process of fatigue elimination the results may be tested. The general health of the worker, his prolonged activity, his posture, his behaviour act as such tests. To

these may be added the amount of skill transferred and being transferred, and the effect, in particular, on "Happiness Minutes." If the organization endorses the work and co-operates in it, the work may be rated successful.

CHAPTER X

THE FUTURE: WHAT EACH ONE OF US CAN DO

The Work of the Colleges.

It should be the work of the colleges to gather together what has been done in fatigue elimination, and to put it at the disposal of all interested. Each college should start a fatigue museum, and should invite its graduates first, and all those in its vicinity second, to co-operate and to send exhibits or pictures of exhibits to its museum. The colleges are recognized as not interested in any particular industry, as fair and impartial, and as standing for uplift in the community. It is, therefore, their duty to act as repositories for the data, at least until such time as the national government takes over the leadership in the entire fatigue question, and becomes the custodian of the data.

The colleges can help in a second way by making fatigue study a subject in the curriculum

It is not necessary that this be a new subject. It should rather be a new aspect in which the old subjects are presented. Especially in the colleges of engineering and business administration great emphasis should be laid upon fatigue study, both the theory and the practice. It is not essential that the students be sent out into the shops for actual practice in such study, although anything like the half-time plan is to be commended. The student may well apply fatigue study to his own activities. This will present an admirable field and a splendid incentive. After such a study the fatigue problem will never again seem remote or vague to the student. Also the student may well be sent, or taken, on tours of inspection through neighbouring industries, or may be allowed to co-operate in preliminary fatigue surveys. They should learn the general principle of fatigue study, and should become fingerwise. This preparation is identical to that for making motion study, and, in fact, is prerequisite or first step for greatest success in any managerial work.

But the college should not confine its activity in fatigue elimination to the museum, and to

training the student who expects to enter the field. They should themselves become examples of successful fatigue elimination. In this way they can do most to cut down waste, and to train our young people to take an active part later in the waste elimination campaign being waged in the world's work.

The Work of the Manager.

The fatigue study and the installation which must follow it to be done by the manager have been outlined in this book. The manager who has put his own plant at such a stage of improvement that unnecessary fatigue is cut out to a great extent, and that recovery from necessary fatigue is provided for, has contributed greatly to the cause, but his work should not end here. He should educate those with whom he comes in contact on the subject of fatigue elimination. He should co-operate with those in his own neighbourhood, and also with those in his own trade towards solving the fatigue problem peculiar to the locality or the trade.

The Home Reading Box has been successfully installed by a group of manufacturers engaged in

the same trade. This particular work furnishes an admirable starting point, and is a great help in arousing local interest. If even a few interested in the same trade in various parts of the country will co-operate, it will soon be possible, through trade journals, and through a general demand for equipment designed from the fatigue standpoint, to revolutionize fatigue conditions in that industry. Editors and writers of papers of all types have been quick to see the benefits of fatigue elimination, and to offer to co-operate in a campaign for education. Manufacturers have been equally eager to satisfy any demands which may be made. The managers can have a large share in making such demands, and in encouraging the support of publications in which they are interested.

The Work of the Worker.

The worker has two chief ways in which he can help in fatigue elimination. The first is to co-operate with the management in installing fatigue elimination methods and devices in the particular plant in which they are both interested. The second is to help to make fatigue

elimination fashionable. This latter duty lies with no one but the worker himself. No new methods spread more quickly than the "fashion of work." There is nothing of which a well run plant is more proud than the "way" it works, the work spirit. The whole idea must be that it is a disgrace to have causes of unnecessary fatigue existing. Overfatigue is a positive proof of inefficiency. There is no fear but that the workers will recognize these duties, and will perform them heartily and with good will, when they know that they are getting a square deal. It is right that they should make very sure that they are going to receive such treatment, and that fatigue study is not a new scheme for taking advantage of them, but they must be ready to listen to the proof and to accept it when they are convinced that it is true. Having accepted it, and thus made sure that they are safe in co-operating, the next step is to help actively in the good work.

The Work of the Public.

The great work of the public is to demand fatigue elimination. The adoption of a few simple slogans, like "Buy of the seated worker," would

help bring immediate results in fatigue elimination. Consider what the Consumers' League has done in securing better working conditions. Note how the "Safety First" movement has spread through the whole country. The "Fatigue Eliminating Movement" can spread in the same way, if only every one will do his part to demand that the fatigue be reduced and to help in the actual reduction.

The workers of the country have long recognized the need for fatigue elimination; the employers are coming to a realization that they are paying a large price for fatigue. Many employers have resolved that, so far as their plants are concerned, needless fatigue must be eliminated. They have resolved that the day is coming when every worker shall go home from work happy in what he has done, with the least amount of unnecessary fatigue, and prepared to go back in perfect condition on the morrow. How soon this much desired time will arrive depends upon the co-operation of the public, upon the public sentiment that can be aroused.

There is no reader of this book who does not belong to at least two groups that should be in-

terested in fatigue elimination. Decide at once, then, in which group you belong, and set to work. Be you teacher, manager, worker, or simply a member of the great public to which we all belong, begin to work for fatigue elimination, and begin now.

The good in your life consists of the quantity of "Happiness Minutes" that you have created or caused. Increase your own record by eliminating unnecessary fatigue of the workers.

CHAPTER XI

PROGRESS SUMMARY: TREND OF DEVELOPMENT

Before the War the question of the relation of fatigue to industrial efficiency seemed to many more or less an academic question. Much of the literature was technical, many of the investigations were as yet in the laboratory stage, and the feeling seemed to prevail in industry that, while fatigue investigations might ultimately prove interesting and profitable in the industrial world, there were other far more important subjects to be considered.

The War has changed all this. With the immediate and increasing realization of the fact that an almost incalculable amount of production was necessary if the Allies were to gain success, came the realization that the human element as well as the materials element must be utilized to the utmost. In this country, as abroad, so-called "theoretical" and "practical" men put their findings together and co-op-

erated in the wartime spirit to use those findings in the industrial world. The result was not only the sudden and profitable using of data that had accumulated during years and that had remained unused, but an interest in the subject throughout the entire community that made fatigue elimination a live topic of the times.

The result of this interest is seen in the increasing literature on the subject; in the reports of the Health of Munition Workers' Committee in England; in the publication there of valuable data collected under Dr. A. F. Stanley Kent at Bristol University; in the popular, yet scientific, "Some Aspects of Industrial Fatigue" by Prof. Henry J. Spooner, Director of the Polytechnic School of Engineering, London, and in his later "Wealth from Waste," in which the human element bears an important part; also in France in an increased interest in the work of Amar and Imbert; also in such writings in our own country as are published by the Government; in books like Prof. Frederic S. Lee's "The Human Machine and Industrial Efficiency," which includes an admirable bibliography of the entire subject, and Mr. P. Sargent

Florence's "Manual," and in such investigations as that made by the National Industrial Conference Board called "Rest Periods for Industrial Workers," published in January of this year.

More important, however, even than the literature of the subject, as reflecting the popular interest, is the practical work in fatigue elimination that has spread throughout the country. In all parts of the country, in all types of occupation, with men and women workers alike, rest periods are being tried. From factories and offices alike come inquiries for fatigue elimination devices, such as chairs, desks and foot-rests. The "Home Reading Box" has become an established institution. The Fatigue Survey is becoming an integral part of the survey plan. Considered in its entirety, the development along the line of fatigue elimination may be acknowledged one of the most satisfactory of wartime activites.

While the pressing need for increased production doubtless was the chief incentive toward this growth, other things more or less directly related to this contributed to it as well. One was the sudden introduction of a large body of

women into industry who had not before engaged in that or similar types of work. In some cases the nature of the work was new. Under both these conditions it was necessary to consider the fatigue problem most seriously, if satisfactory results were to be gained. We may not all agree with Prof. Amar's radical findings in his latest paper, "Physiologie du Travail Feminin"—we must all rejoice that such a careful investigator is devoting his attention to the subject. A second new element in industry was constituted by the returned crippled or blinded soldiers, who also demanded special attention from the fatigue standpoint. Another factor in the growth of fatigue elimination has been the increase of interest in Scientific Management and efficiency methods. A consideration of fatigue is an integral part of such management, and the introduction of the new methods automatically brought about fatigue elimination. Not the least important element has been the entering into government service of leaders in all lines of activity, who immediately put their past experience and their best powers at the service of the country in her hour of need. Never before has such

a body of men and women gathered together and co-operated to increased national efficiency. With leadership like this, with the experience, resources and powers of the entire country at the disposal of the leaders, with a spirit of co-operation extending throughout the length and breadth of the land, it is not remarkable that enormous progress has taken place.

As a result of all this, it is perhaps, not too much to say that fatigue elimination has become "fashionable." Nothing finer could be asked for. No great progress could be made in "Safety First," in Accident Prevention, until the entire movement became fashionable. In the old days, when recklessness, daring, and pride in hazardous exploits were matters of commendation, accident prevention was a matter of ridicule. In these times when "recklessness" receives its proper name of "foolhardiness"; when accident prevention is realized as conservation, assured and continuous progress is inevitable. The same thing is true of fatigue elimination. In the old days, to acknowledge fatigue was effeminate. To make provision for eliminating fatigue ranked with "babying" one's self.

or others, and anything that was done was too often turned over to the "Welfare Department," so called. To-day all this is changed. Fatigue elimination has come into its own — it has become "fashionable."

As for the cost of fatigue elimination — much important work can be done at very slight cost, simply by teaching all members of the organization to *think* in terms of cutting out fatigue. Even where a real fatigue elimination campaign is made the cost can be much reduced by utilizing existing activity. Where there is a well established chart department, and it is customary to note on the chart,— as should always be done,— causes of deviation from standards, the effect of the introduction of fatigue eliminating devices and methods can be noted with little added expense. However, no matter how elaborate nor apparently costly the investigations may be, experience shows that they more than pay for themselves in results, not only in increasing the product, but in promoting co-operation throughout the plant. As the government investigations show, and as government printed reports will show more and more, the

elimination of fatigue is a problem not only for individual plants, but for entire communities and industries,— starting at both ends of the scale will mean not only immediate results but greatly decreased costs.

Thus far our report sounds fairly encouraging. The danger, however, is this. With the stresses of wartime more or less decreased, with other interests pressing to the fore, there is a great likelihood that interest in fatigue elimination will die out, or that the work will be carried on by those only who have such a thorough understanding of the subject that they realize its importance. Now, while the scientific investigations that all writers on fatigue agree form the basis of successful work must be carried on, it is more important at the present stage that popular interest in the subject be maintained, and that the industries themselves carry on the splendid work begun. Just as, economically, we are coming to realize that increased production is imperative, so, both from the human and the materials standpoint, we must realize that fatigue elimination is equally imperative. Surely we have no intention of

slipping back into the unprogressive methods of "before the War," nor as allowing such improvements as were made as "War Measures" to lapse.

It is scarcely necessary to review the simple, almost elementary outline of what fatigue elimination means. To say that it consists of two parts, first, eliminating unnecessary fatigue from the operation and, second, providing for recuperation from necessary fatigue involved therein; that the first step is to make a survey, as detailed as possible of present procedure, and of possible ultimate improvements; that the length of the working day and the length of work and rest periods are important elements; that the height of the work-place is the determining factor in deciding upon proper height of chair, type of foot-rest, etc. The increasing literature on all the variables of the worker, the working conditions, equipment and tools, and the motions involved, make it increasingly easier for the interested investigator to find the material he needs for this work.

Added aid is to be found in the new elements that are coming into industry. The pioneer

lectures now being given by Dr. Southard and the staff of the Psychopathic Hospital in Boston to the Harvard Employment Managers' Course, have demonstrated the place that Mental Hygiene is to take in industrial development. The psychiatrist, with his specialized knowledge of the psychopathic manifestations of fatigue, will prove an immense stimulus in the work of fatigue elimination. The expert in social work, who is also coming into the industrial field can trace the causes and effects of fatigue to the life of the worker outside the plant, and thus contribute a much needed factor to the investigations. The psychologist who is already a recognized part of the progressive industrial staff, is well equipped with tests that are of assistance, and, as Prof. Lee so admirably points out in his book, the physiologist who after all this, perhaps, the most needed investigator in this field, is amply equipped with the knowledge and experience to do his share in the great work.

The great necessity is to recognize the importance of fatigue elimination; to acquaint oneself with the progress in the past; to insist upon maintenance of the best that has been

done; to assist in the development, and to welcome into the field those workers who can be of so much assistance. If this is done, there can be no question but that the reconstruction period will show wonderful advancement along this line, and that progress reports of the future will show even more decided gains than have those in the past. The subject is one of interest to employers and workers alike,— one of those fundamental things upon which we all agree; which enlists the co-operation of workers in a plant, of plants in an industry, of industries in a community, and of communities in a nation and internationally. It is a War problem. It is a Peace problem. It is in the highest sense constructive.

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